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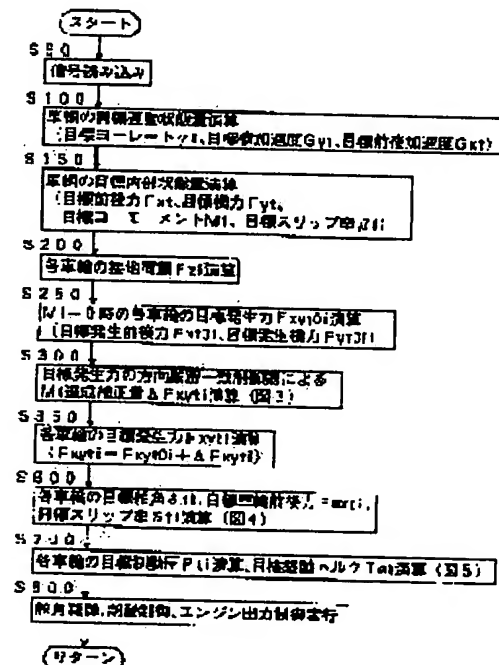
(71)Applicant : TOYOTA MOTOR CORP
 TOYOTA CENTRAL RES & DEV LAB INC
 (72)Inventor : INAGAKI SHOJI
 HATTORI YOSHIKAZU

(54) RUNNING CONTROLLER FOR VEHICLE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve the running property of a vehicle more than the running property of a vehicle using a conventional running controller by controlling a steering angle of each wheel and controlling a generation force of each wheel.

SOLUTION: A target front and rear force F_{xt} , a target lateral force F_{yt} , and a target yaw moment M_t of the vehicle are computed (S100, 150), a first target generation force F_{xyt0i} of each wheel achieving the target front and rear force F_{xt} and the target lateral force F_{yt} is computed without giving yaw moment to the vehicle (S200, 250), a second target generation force ΔF_{xyti} of each wheel for achieving the target yaw moment M_t only of the vehicle is computed (S300), and the target generation force F_{xyti} of each wheel as the sum of F_{xyt0i} and ΔF_{xyti} is computed (S350). A target steering angle δ_{ti} , a target wheel front and rear force F_{wxti} , and a target slip rate Sti of each wheel achieving the target generation force F_{xyti} are computed (S600), and a target braking pressure P_{ti} of each wheel and a target drive torque T_{et} of an engine are computed (S700) to control so that a steering angle of each wheel becomes the target steering angle δ_{ti} , an output torque of the engine 10 becomes the target drive torque T_{et} , and a braking pressure of each wheel becomes the target braking pressure P_{ti} (S800).



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CLAIMS

[Claim(s)]

[Claim 1] The rudder angle and braking/driving force of each wheel are used as the transit control unit of the vehicle equipped with the controllable rudder angle control means and the braking/driving force control means according to the individual, respectively. A means to detect the amount of steering control operation by the operator, and a means to detect the amount of driving force control operation by the operator, A means to detect the amount of damping force control operation by the operator, and the amount of steering control operation by the operator, A vehicle target quantity of state operation means to calculate the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle based on the amount of driving force control operation, and the amount of damping force control operation, Said target order force, said target lateral force, and a wheel target generating force operation means to calculate the target generating force of each wheel based on said target yaw moment, A wheel target controlled-variable operation means to calculate the target rudder angle and target braking/driving torque of each wheel based on the target generating force of each of said wheel, The transit control unit of the vehicle characterized by having the control means which controls said rudder angle control means and said braking/driving force control means so that the rudder angle and braking/driving torque of each wheel turn into said target rudder angle and said target braking/driving torque, respectively.

[Claim 2] While the direction of resultant force of the target generating force of each of said wheel meets towards resultant force with the target order force of said vehicle, and the target lateral force of said vehicle, said wheel target generating force operation means The transit control unit of the vehicle according to claim 1 characterized by determining the magnitude and the direction of the target generating force of said each wheel that the target order force of said vehicle, the target lateral force of said vehicle, and the target yaw moment of said vehicle are attained by resultant force of the target generating force of each of said wheel.

[Claim 3] The first target generating force operation means which calculates the first target generating force of each wheel for attaining the target order force of said vehicle, and the target lateral force of said vehicle, without said wheel target generating force operation means giving said target yaw moment to a vehicle, It has the second target generating force operation means which calculates the second target generating force of each wheel for attaining only said target yaw moment. The transit control unit of the vehicle according to claim 2 characterized by calculating the target generating force of each of said wheel as the sum of said first target generating force and said second target generating force.

[Claim 4] Said vehicle has a right-and-left front wheel and a right-and-left rear wheel, and said wheel target generating force operation means has a means to search for the touch-down load of each wheel. Said first target generating force operation means calculates the first target generating force of each of said wheel by distributing resultant force with the target order force of said vehicle, and the target lateral force of said vehicle to each wheel in proportion to the touch-down load of each wheel. Said second target generating force operation means in order to attain only said target yaw moment based on the direction of resultant force with said target yaw moment and the target order force of said vehicle, and the target lateral force of said vehicle A means to calculate the yaw moment generating force of a rear wheel of making fixed relation to the yaw moment generating force of said front wheel as the sum total of the force which a right-and-left rear wheel should generate while calculating the yaw moment generating force of a front wheel as the sum total of the force which a right-and-left front wheel should generate, While distributing the yaw moment generating force of said front wheel to a right-and-left front wheel in proportion to the touch-down load of a right-and-left front wheel The transit control unit of the vehicle according to claim 3 characterized by having a means to calculate the second target generating force of each of said wheel by distributing the yaw moment generating force of said rear wheel to a right-and-left rear wheel in proportion to the touch-down load of a right-and-left rear wheel.

[Claim 5] Said wheel target generating force operation means has a means to search for the touch-down load of each wheel. Said first target generating force operation means calculates the first target generating force of each of said wheel by distributing resultant force with the target order force of said vehicle, and the target lateral force of said vehicle to each wheel in proportion to the touch-down load of each wheel. A wheel specification means to specify the wheel made suitable for generating [means / said / second / target generating force operation] said second target generating force efficiently based on the target order force of said vehicle, and the target lateral force of said vehicle, It has a means to calculate said second target generating force as force of a direction perpendicular to said first target generating force about said specified wheel. A means by which said wheel target generating force operation means sets the target generating force of said specified wheel as resultant force with said first target generating force and said second target generating force, A means to set the target generating force of wheels other than said specified wheel as said first target generating force of corresponding, So that resultant force with said target generating force of said specified wheel and said target generating force of wheels other than said specified wheel may attain the target order force of said vehicle, and the target lateral force of said vehicle The transit control unit of the vehicle according to claim 3 characterized by having a means to amend the magnitude of said target generating force of said specified wheel, and said target generating force of wheels other than said specified wheel.

[Claim 6] Said wheel specification means is the transit control unit of the vehicle according to claim 6 with which the arm length of the yaw moment of the circumference of the center of gravity of the vehicle by said second target generating force is characterized by specifying the wheel of the larger one among wheels on either side as a wheel made suitable for generating said second target generating force efficiently.

[Claim 7] A means to calculate the target travelling direction angle of the grounding point of each wheel [as opposed to the cross direction of a vehicle in said wheel target controlled-variable operation means], A means to calculate the target touch-down load of each wheel, and a means to calculate the target wheel order force and target wheel lateral force in the wheel coordinate of each wheel based on said target generating force and the last target rudder angle, A means to calculate the target slip angle of each wheel as the sum of the target travelling direction angle of the grounding point of each of said wheel, and the last target rudder angle, A means to calculate the lateral-force generating forecast and target slip ratio of each wheel based on the target wheel order force of each of said

wheel, the target slip angle of each of said wheel, and the target touch-down load of each of said wheel, The transit control unit of the vehicle according to claim 1 characterized by having a means to calculate the target rudder angle and target running torque of each wheel based on the target wheel order force of each of said wheel, the target wheel lateral force of each of said wheel, the lateral-force generating forecast of each of said wheel, and the target slip ratio of each of said wheel.

[Claim 8] A means to calculate the target rudder angle and target running torque of each of said wheel When the magnitude of the deflection of said target wheel lateral force and said lateral-force generating forecast is under a reference value Set the target rudder angle of each wheel as the last target rudder angle, and when the magnitude of the deflection of said target wheel lateral force and said lateral-force generating forecast is beyond a reference value The transit control unit of the vehicle according to claim 7 characterized by the last target rudder angle setting the value corrected in said amount of target rudder angle corrections as the target rudder angle of each wheel while calculating the amount of target rudder angle corrections based on the deflection of said target wheel lateral force and said lateral-force generating forecast.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the transit control unit of a vehicle, and relates the rudder angle and braking/driving force of each wheel to a detail according to an individual further at the transit control unit of a controllable vehicle.

[0002]

[Description of the Prior Art] As one of the transit control units of vehicles, such as an automobile, the transit control unit constituted so that the yaw moment of a vehicle might be controlled is conventionally known by controlling the damping force of each wheel according to an individual based on a vehicle model and a tire model as indicated by for example, the Patent Publication Heisei No. 500380 [11 to] official announcement official report. According to this kind of transit control unit, it can be made to run a vehicle stably as compared with the case where the yaw moment of a vehicle is not controlled.

[0003]

[Problem(s) to be Solved by the Invention] Generally, transit movement of a vehicle is prescribed by the vehicle order force, lateral force, and the yaw moment, and the vehicle order force, lateral force, and the yaw moment are determined by the magnitude and the direction of the force which each wheel generates to a road surface. Moreover, in order to make it run a vehicle that it is proper and stably according to an operator's operation, the magnitude and the direction of the force which each wheel generates to a road surface must be controlled so that the vehicle order force, lateral force, and the yaw moment must be controlled by the desired value corresponding to an operator's steering control operation, driving force control operation, and damping force control operation, therefore the vehicle order force, lateral force, and the yaw moment become desired value.

[0004] However, it sets to the conventional transit control unit like ****. Since only the braking/driving force of a wheel is controlled on the assumption that the rudder angle of a steering wheel is a rudder angle corresponding to an operator's steering control operation and the rudder angle of a non-steering wheel is constancy, A limitation is in the magnitude of the force which each wheel generates, and the control range of a direction, and the engine performance of a wheel (tire) cannot be demonstrated to the maximum extent, therefore there is room of an improvement in the conventional transit control unit at the point which raises the performance traverse of a vehicle.

[0005] Moreover, it sets to the conventional common transit control unit. The braking/driving force of each wheel is controlled by feedback control according to an individual so that this deflection becomes small based on the deflection of the target behavior index value of a vehicle, and the actual behavior index value of a vehicle. Since transit control is performed that it should cope with that the actual behavior of a vehicle shifted from target behavior and feedback gain cannot be made high from the need for stability reservation of control, such as antihunting, There is room of an improvement at the point which cannot control transit movement of a vehicle certainly and effectively, therefore raises the performance traverse of a vehicle also to the conventional common transit control unit.

[0006] This invention is made in view of the problem like **** in the conventional transit control unit constituted so that transit movement of a vehicle might be controlled by controlling the braking/driving force of each wheel. While the main technical problems of this invention expand the magnitude of the force which also makes the rudder angle of each wheel a controlled system, and each wheel generates, and the control range of a direction By controlling the magnitude and the direction of the force which each wheel generates so that it may become in the magnitude and the direction required to attain transit movement of the proper vehicle corresponding to an operator's operation, it is raising the performance traverse of a vehicle as compared with the case of the conventional transit control unit.

[0007]

[Means for Solving the Problem] According to this invention, main above-mentioned technical problems are made into the configuration of claim 1, i.e., the transit control unit of a vehicle equipped with the controllable rudder angle control means and the braking/driving force control means for the rudder angle and braking/driving force of each wheel according to the individual, respectively. A means to detect the amount of steering control operation by the operator, and a means to detect the amount of driving force control operation by the operator, A means to detect the amount of damping force control operation by the operator, and the amount of steering control operation by the operator, A vehicle target quantity of state operation means to calculate the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle based on the amount of driving force control operation, and the amount of damping force control operation, Said target order force, said target lateral force, and a wheel target generating force operation means to calculate the target generating force of each wheel based on said target yaw moment, A wheel target controlled-variable operation means to calculate the target rudder angle and target braking/driving force of each wheel based on the target generating force of each of said wheel, It is attained by the transit control unit of the vehicle characterized by having the control means which controls said rudder angle control means and said braking/driving force control means so that the rudder angle and braking/driving force of each wheel turn into said target rudder angle and said target braking/driving force, respectively.

[0008] According to the configuration of above-mentioned claim 1, a vehicle is equipped with a controllable rudder angle control means according to an individual for the rudder angle of each wheel. It is based on the amount of steering control operation by the operator, the amount of driving force control operation, and the amount of damping force control operation. The target order force of a vehicle, The target lateral force of a vehicle and the target yaw moment of a vehicle calculate. The target order force of a vehicle, The target generating force of each wheel calculates based on the target lateral force of a vehicle, and the target yaw moment of a vehicle. Since it is controlled so that the target rudder angle and target braking/driving torque of each wheel calculate based on the target generating force of each wheel and the rudder angle and braking/driving torque of each wheel turn into a target rudder angle and target braking/driving torque, respectively As compared with the case where the rudder angle and braking/driving torque of each wheel are

controlled so that the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are attained by the generating force of each wheel, and only the braking/driving force of each wheel is controlled by this, the performance traverse of a vehicle improves certainly.

[0009] Moreover, according to this invention, it sets in the configuration of above-mentioned claim 1 that main above-mentioned technical problems should be attained effectively. While the direction of resultant force of the target generating force of each of said wheel meets towards resultant force with the target order force of said vehicle, and the target lateral force of said vehicle, said wheel target generating force operation means It is constituted so that the magnitude and the direction of the target generating force of said each wheel may be determined that the target order force of said vehicle, the target lateral force of said vehicle, and the target yaw moment of said vehicle are attained by resultant force of the target generating force of each of said wheel (configuration of claim 2).

[0010] While the direction of resultant force of the target generating force of each wheel meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle according to the configuration of claim 2 Since the magnitude and the direction of the target generating force of each wheel are determined that the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are attained by resultant force of the target generating force of each wheel The magnitude and the direction of the target generating force of each wheel are determined that the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are efficiently attained by the generating force of each wheel.

[0011] Moreover, according to this invention, it sets in the configuration of above-mentioned claim 2 that main above-mentioned technical problems should be attained effectively. The first target generating force operation means which calculates the first target generating force of each wheel for attaining the target order force of said vehicle, and the target lateral force of said vehicle, without said wheel target generating force operation means giving said target yaw moment to a vehicle, It has the second target generating force operation means which calculates the second target generating force of each wheel for attaining only said target yaw moment, and it is constituted so that the target generating force of each of said wheel may be calculated as the sum of said first target generating force and said second target generating force (configuration of claim 3).

[0012] The first target generating force of each wheel for attaining the target order force of a vehicle and the target lateral force of a vehicle according to the configuration of claim 3, without giving the target yaw moment to a vehicle calculates. Since the second target generating force of each wheel for attaining only the target yaw moment calculates and the target generating force of each wheel calculates as the sum of the first target generating force and the second target generating force The target generating force of each wheel calculates so that the target order force of a vehicle, target lateral force, and the target yaw moment may be attained certainly.

[0013] Moreover, according to this invention, it sets in the configuration of above-mentioned claim 3 that main above-mentioned technical problems should be attained effectively. Said vehicle has a right-and-left front wheel and a right-and-left rear wheel, and said wheel target generating force operation means has a means to search for the touch-down load of each wheel. Said first target generating force operation means calculates the first target generating force of each of said wheel by distributing resultant force with the target order force of said vehicle, and the target lateral force of said vehicle to each wheel in proportion to the touch-down load of each wheel. Said second target generating force operation means in order to attain only said target yaw moment based on the direction of resultant force with said target yaw moment and the target order force of said vehicle, and the target lateral force of said vehicle A means to calculate the yaw moment generating force of a rear wheel of making fixed relation to the yaw moment generating force of said front wheel as the sum total of the force which a right-and-left rear wheel should generate while calculating the yaw moment generating force of a front wheel as the sum total of the force which a right-and-left front wheel should generate, While distributing the yaw moment generating force of said front wheel to a right-and-left front wheel in proportion to the touch-down load of a right-and-left front wheel By distributing the yaw moment generating force of said rear wheel to a right-and-left rear wheel in proportion to the touch-down load of a right-and-left rear wheel, it is constituted so that it may have a means to calculate the second target generating force of each of said wheel (configuration of claim 4).

[0014] According to the configuration of claim 4, the touch-down load of each wheel is searched for, and the first target generating force of each wheel calculates by distributing resultant force with the target order force of a vehicle, and the target lateral force of a vehicle to each wheel in proportion to the touch-down load of each wheel. In order to attain only the target yaw moment based on the direction of resultant force with the target yaw moment and the target order force of a vehicle, and the target lateral force of a vehicle The yaw moment generating force of a rear wheel of making fixed relation to the yaw moment generating force of a front wheel as the sum total of the force which a right-and-left rear wheel should generate while the yaw moment generating force of a front wheel calculates as the sum total of the force which a right-and-left front wheel should generate calculates. Since the second target generating force of each wheel calculates by distributing the yaw moment generating force of a rear wheel to a right-and-left rear wheel in proportion to the touch-down load of a right-and-left rear wheel while the yaw moment generating force of a front wheel is distributed to a right-and-left front wheel in proportion to the touch-down load of a right-and-left front wheel Without the direction of resultant force of the target generating force of each wheel breaking down the relation which meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle Moreover, the second target generating force of each wheel of attaining the target yaw moment calculates certainly, without breaking down greatly the relation in which the target generating force of each wheel is proportional to the touch-down load of each wheel.

[0015] Moreover, according to this invention, it sets in the configuration of above-mentioned claim 3 that main above-mentioned technical problems should be attained effectively. Said wheel target generating force operation means has a means to search for the touch-down load of each wheel. Said first target generating force operation means calculates the first target generating force of each of said wheel by distributing resultant force with the target order force of said vehicle, and the target lateral force of said vehicle to each wheel in proportion to the touch-down load of each wheel. A wheel specification means to specify the wheel made suitable for generating [means / said / second / target generating force operation] said second target generating force efficiently based on the target order force of said vehicle, and the target lateral force of said vehicle, It has a means to calculate said second target generating force as force of a direction perpendicular to said first target generating force about said specified wheel. A means by which said wheel target generating force operation means sets the target generating force of said specified wheel as resultant force with said first target generating force and said second target generating force, A means to set the target generating force of wheels other than said specified wheel as said first target generating force of corresponding, So that resultant force with said target generating force of said specified wheel and said target generating force of wheels other than said specified wheel may attain the target order force of said vehicle, and the target lateral force of said vehicle It is constituted so that it may have a means to amend the magnitude of said target generating force of said specified wheel, and said target generating force of wheels other than said specified wheel (configuration of claim 5).

[0016] According to the configuration of claim 5, the touch-down load of each wheel is searched for, and the first target generating force of each wheel calculates by distributing resultant force with the target order force of a vehicle, and the target lateral force of a vehicle to each wheel in proportion to the touch-down load of each wheel. The wheel made suitable for generating the second target

generating force efficiently based on the target order force of a vehicle and the target lateral force of a vehicle is specified. The second target generating force calculates as force of a direction perpendicular to the first target generating force about the specified this wheel. The target generating force of the specified wheel is set as resultant force with the first target generating force and the second target generating force. It is set as the first target generating force in which the target generating force of wheels other than the specified wheel corresponds. Since the magnitude of the target generating force of each wheel is amended so that resultant force with the target generating force of the specified wheel and the target generating force of wheels other than the specified wheel may attain the target order force of a vehicle, and the target lateral force of a vehicle Without the direction of resultant force of the target generating force of each wheel breaking down the relation which meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle, while the target generating force of each wheel is proportional to the touch-down load of each wheel completely The target generating force of each wheel for attaining the target order force of a vehicle, target lateral force, and the target yaw moment calculates certainly.

[0017] Moreover, that main above-mentioned technical problems should be attained effectively, as a wheel made suitable for generating said second target generating force efficiently, among wheels on either side, according to this invention, in the configuration of above-mentioned claim 5, said wheel specification means is constituted so that the arm length of the yaw moment of the circumference of the center of gravity of the vehicle by said second target generating force may specify the wheel of the larger one (configuration of claim 6).

[0018] According to the configuration of claim 6, as a wheel made suitable for generating the second target generating force efficiently, since a wheel with the larger arm length of the yaw moment of the circumference of the center of gravity of the vehicle by the target generating force of [second] the wheels on either side is specified As compared with the case where other wheels are specified, the magnitude of the second target generating force may be small, and the amount of amendments to the magnitude of the target generating force of the wheel specified by this and the target generating force of wheels other than the specified wheel also becomes small.

[0019] Moreover, a means to calculate the target travelling direction angle of the grounding point of each wheel [as opposed to the cross direction of a vehicle in said wheel target controlled-variable operation means] in the configuration of above-mentioned claim 1 that main above-mentioned technical problems should be attained effectively according to this invention, A means to calculate the target touch-down load of each wheel, and a means to calculate the target wheel order force and target wheel lateral force in the wheel coordinate of each wheel based on said target generating force and the last target rudder angle, A means to calculate the target slip angle of each wheel as the sum of the target travelling direction angle of the grounding point of each of said wheel, and the last target rudder angle, A means to calculate the lateral-force generating forecast and target slip ratio of each wheel based on the target wheel order force of each of said wheel, the target slip angle of each of said wheel, and the target touch-down load of each of said wheel, It is constituted so that it may have a means to calculate the target rudder angle and target running torque of each wheel based on the target wheel order force of each of said wheel, the target wheel lateral force of each of said wheel, the lateral-force generating forecast of each of said wheel, and the target slip ratio of each of said wheel (configuration of claim 7).

[0020] According to the configuration of claim 7, the target travelling direction angle of the grounding point of each wheel to the cross direction of a vehicle calculates. The target touch-down load of each wheel calculates, and the target wheel order force and target wheel lateral force in the wheel coordinate of each wheel calculate based on the target generating force and the last target rudder angle. The target slip angle of each wheel calculates as the sum of the target travelling direction angle of the grounding point of each wheel, and the last target rudder angle. Based on the target wheel order force of each wheel, the target slip angle of each wheel, and the target touch-down load of each wheel, the lateral-force generating forecast and target slip ratio of each wheel calculate. Since the target rudder angle and target running torque of each wheel calculate based on the target wheel order force of each wheel, the target wheel lateral force of each wheel, the lateral-force generating forecast of each wheel, and the target slip ratio of each wheel The target rudder angle of each wheel for attaining the target generating force of each wheel and the target braking/driving torque of each wheel calculate certainly.

[0021] According to this invention, in the configuration of above-mentioned claim 7, moreover, a means to calculate the target rudder angle and target running torque of each of said wheel that main above-mentioned technical problems should be attained effectively When the magnitude of the deflection of said target wheel lateral force and said lateral-force generating forecast is under a reference value Set the target rudder angle of each wheel as the last target rudder angle, and when the magnitude of the deflection of said target wheel lateral force and said lateral-force generating forecast is beyond a reference value While calculating the amount of target rudder angle corrections based on the deflection of said target wheel lateral force and said lateral-force generating forecast, it is constituted so that the last target rudder angle may set the value corrected in said amount of target rudder angle corrections as the target rudder angle of each wheel (configuration of claim 8).

[0022] When the magnitude of the deflection of target wheel lateral force and a lateral-force generating forecast is under a reference value according to the configuration of claim 8 The target rudder angle of the wheel concerned is set as the last target rudder angle, and when the magnitude of the deflection of target wheel lateral force and a lateral-force generating forecast is beyond a reference value Since the value from which the last target rudder angle was corrected in the amount of target rudder angle corrections is set as the target rudder angle of the wheel concerned while the amount of target rudder angle corrections calculates based on the deflection of target wheel lateral force and a lateral-force generating forecast, it calculates certainly, without the target rudder angle of each wheel emitting.

[0023]

[The desirable mode of a technical-problem solution means] According to one desirable mode of this invention, it sets in the configuration of above-mentioned claim 1. The amount of steering control operation according [a vehicle target quantity of state operation means] to an operator, the amount of driving force control operation, It is based on the amount of damping force control operation. The target order acceleration of a vehicle, the target lateral acceleration of a vehicle, It is constituted so that the target yaw rate of a vehicle may be calculated and the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle may be calculated based on the target order acceleration of a vehicle, the target lateral acceleration of a vehicle, and the target yaw rate of a vehicle, respectively (desirable mode 1).

[0024] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 1, a braking/driving force control means is constituted so that it may consist of a driving force control means and a damping force control means (desirable mode 2).

[0025] other one desirable voice of this invention -- if it depends like -- the above -- in the configuration of the desirable mode 2, a driving force control means controls the driving force of all wheels in the gross, and in the damping force of each wheel, a damping force control means is constituted so that it may be controllable according to an individual (desirable mode 3).

[0026] other one desirable voice of this invention -- if it depends like -- the above -- in the configuration of the desirable mode 2, it is

constituted so that the driving force control means may be controllable according to an individual in the driving force of each wheel and the damping force control means may be controllable according to an individual in the damping force of each wheel (desirable mode 4).

[0027] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 1, a vehicle is constituted so that it may be the four-flower vehicle which has a right-and-left front wheel and a right-and-left rear wheel (desirable mode 5).

[0028] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 4, the yaw moment generating force of a front wheel and the yaw moment generating force of a rear wheel are constituted so that it may be the same value (desirable mode 6).

[0029] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 4, distance of the vehicle cross direction between the center of gravity of a vehicle and a front-wheel axle is set to L_f , and by setting distance of the vehicle cross direction between the center of gravity of a vehicle, and a rear wheel axle to L_r , the ratio of the magnitude of the yaw moment generating force of a front wheel to the magnitude of the yaw moment generating force of a rear wheel is constituted so that it may be L_r/L_f (desirable mode 7).

[0030] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 4, a means to search for the touch-down load of each wheel is constituted so that the touch-down load of each wheel may be calculated by presumption based on the mass of a vehicle, vehicle order acceleration, and the lateral acceleration of a vehicle (desirable mode 8).

[0031] According to other one desirable mode of this invention, it sets in the configuration of above-mentioned claim 5. A vehicle is a four-flower vehicle which has a right-and-left front wheel and a right-and-left rear wheel, and when the target order force of a vehicle and the target lateral force of a vehicle are not 0, a wheel specification means It is constituted so that two wheels of a forward left ring and a right rear ring or a forward right ring, and a left rear ring may be specified based on the direction of the target order force of a vehicle, and the direction of the target lateral force of a vehicle (desirable mode 9).

[0032] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 5, a vehicle is a four-flower vehicle which has a right-and-left front wheel and a right-and-left rear wheel, and when the target order force of a vehicle or the target lateral force of a vehicle is 0, a wheel specification means is constituted so that all wheels may be specified (desirable mode 10).

[0033] In the desirable mode 9 or the configuration of 10 other one desirable voice of this invention -- if it depends like -- the above -- When larger than the magnitude of the first target generating force of a wheel in which the magnitude of the second calculated target generating force was specified, a means to calculate the second target generating force is constituted so that the magnitude of the second target generating force may be amended in the magnitude of the first target generating force of the wheel concerned (desirable mode 11).

[0034] According to other one desirable mode of this invention, it sets in the configuration of above-mentioned claim 7. The driving force control means which controls the driving force of all wheels in the gross when a vehicle has the drive system which transmits the driving torque of a driving source and a driving source to each wheel by the fixed allocation ratio and a braking/driving force control means controls the driving torque of a driving source, The damping force of each wheel is consisted of a controllable damping force control means according to an individual. Said control means calculates the target driving torque of a driving source based on the maximum of a driving side among the target running torques of each wheel. It is constituted so that a target damping force controlled variable may be calculated based on said maximum and the target running torque of other wheels about other wheels other than the wheel whose target running torque is max (desirable mode 12).

[0035] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 7, a means to calculate the target rudder angle and target running torque of each wheel is constituted so that the amount of corrections of the target rudder angle of each wheel may be calculated based on the target wheel lateral force and the lateral-force generating forecast of each wheel and the target rudder angle of each wheel may be calculated as the sum with the amount of corrections of the last target rudder angle and a target rudder angle (desirable mode 13).

[0036] According to other one desirable mode of this invention, it sets in the configuration of above-mentioned claim 7. A means to calculate the target rudder angle and target running torque of each wheel calculates the target wheel acceleration of each wheel based on the target slip ratio of each wheel. It is constituted so that the target running torque of each wheel may be calculated as the sum of the first [based on the target wheel order force of each wheel] target running torque, and the second [based on the target wheel acceleration of each wheel] target running torque (desirable mode 14).

[0037] According to other one desirable mode of this invention, in the configuration of above-mentioned claim 8, a means to calculate the target rudder angle and target running torque of each wheel is constituted so that the amount of target rudder angle corrections may be calculated as a value proportional to the deflection of target wheel lateral force and a lateral-force generating forecast (desirable mode 15).

[0038]

[Embodiment of the Invention] This invention is explained to a detail about some desirable operation gestalten, referring to drawing of attachment in the following.

[0039] The first operation gestalt drawing 1 is the outline block diagram showing the first operation gestalt of the transit control unit of the vehicle by this invention.

[0040] In drawing 1, 10 shows the engine as a driving source carried in the vehicle 12, the driving force of an engine 10 is transmitted to an output shaft 18 through a torque converter 14 and transmission 16, and the driving force of an output shaft 18 is transmitted to the driveshaft 22 for front wheels, and the driveshaft 24 for rear wheels by the pin center, large differential 20. The output of an engine 10 is controlled by the engine control system 26 by drawing 1 operated by the operator according to the amount of treading in of the accelerator pedal which is not shown etc.

[0041] The driving force of the driveshaft 22 for front wheels is transmitted to forward left ring axle 32L and forward right ring axle 32R by the front-wheel differential 30, and, thereby, the rotation drive of front-wheel 34floor line and 34FR on either side is carried out. Similarly, the driving force of the driveshaft 24 for rear wheels is transmitted to left rear ring axle 38L and right rear ring axle 38R by the rear wheel differential 36, and, thereby, the rotation drive of rear wheel 40RL on either side and the 40RR(s) is carried out.

[0042] A torque converter 14, transmission 16, the pin center, large differential 20, the front-wheel differential 30, and the rear wheel differential 36 grade constitute the drive system of a vehicle in this way. Especially the drive system of the operation gestalt of illustration distributes the driving torque of an engine 10 by the fixed allocation ratio to right-and-left front-wheel 34floor line, 34FR and right-and-left rear wheel 40RL, and 40RR, and an engine control system 26 controls the driving torque transmitted to each wheel from an engine 10 in the gross.

[0043] Front-wheel 34floor line on either side, 34FR and rear wheel 40RL on either side, and the damping force of 40RR are

controlled by controlling the braking pressure of wheel-cylinder 46floor line which corresponds by the hydraulic circuit 44 of a damping device 42, 46FR, 46RL, and 46RR. Although not shown in drawing, it is controlled by the electronic control 50 for transit control according to an individual to be controlled by the master cylinder 48 driven according to the treading strength to the brake pedal 47 usually according [the braking pressure of each wheel cylinder] to an operator in the time including a reservoir, an oil pump, various valve gears, etc. in a hydraulic circuit 44, and to explain to a detail later if needed.

[0044] Moreover, front-wheel 34floor line and 34FR on either side are steered with the power steering system 52 for front wheels as shown in drawing 1. In the operation gestalt of illustration, it has hydraulic power-steering equipment 56 which the power steering system 52 for front wheels answers steering actuation of the steering wheel 54 by the operator, and is driven, and front-wheel 34floor line and 34FR on either side are steered through tie rods 58L and 58R by power-steering equipment 56.

[0045] The actuators 60L and 60R which carry out adjustable control of those effective length, respectively are formed in tie rods 58L and 58R, Actuators 60L and 60R are controlled by the rudder angle control unit 62, and, thereby, the rudder angle of front-wheel 34floor line on either side and 34FR is mutually controlled independently in rear wheel 40RL and 40RR(s).

[0046] Similarly, rear wheel 40RL on either side and 40RR(s) are steered with the power steering system 64 for rear wheels. It has hydraulic power-steering equipment 66 which the power steering system 64 for rear wheels answers the steering actuation of a steering wheel 54 and the vehicle speed by the operator, and is driven, and 40RL(s) of a rear wheel on either side and 40RR(s) are steered through tie rods 68L and 68R by power-steering equipment 66.

[0047] The actuators 70L and 70R which carry out adjustable control of those effective length, respectively are formed in tie rods 68L and 68R, power-steering equipment 66 and Actuators 70L and 70R are controlled by the rudder angle control unit 62, and, thereby, the rudder angle of rear wheel 40RL on either side and 40RR(s) is mutually controlled independently with front-wheel 34floor line and 34FR.

[0048] The power steering system 52 for front wheels, the power steering system 64 for rear wheels, and the rudder angle control unit 62 so that the above explanation may show Each wheel 34floor line, The controllable rudder angle control means is constituted for the rudder angle of 34FR, 40RL, and 40RR according to an individual. An engine 10, an engine control system 26, a damping device 42, and an electronic control 50 have two incomes mutually, and constitute the controllable braking/driving force control means for the braking/driving force of each wheel according to an individual, and an electronic control 50 functions as a control means which controls a rudder angle control means and a braking/driving force control means.

[0049] an electronic control -- 50 -- **** -- a speed sensor -- 72 -- the vehicle speed -- V_x -- being shown -- a signal -- order -- an acceleration sensor -- 74 -- and -- lateral acceleration -- a sensor -- 76 -- respectively -- a vehicle -- 12 -- order -- acceleration -- G_x -- and -- lateral acceleration -- G_y -- being shown -- a signal -- a shift -- a position -- (-- SP --) -- a sensor -- 78 -- transmission -- 16 -- a shift -- a position -- P_s -- being shown -- a signal -- treading strength -- a sensor -- 80 -- a brake pedal -- 47 -- receiving -- treading strength -- F_b (the amount of braking control operation by the operator) -- be shown -- a signal -- inputting -- having -- . In addition, the amount of braking control operation by the operator may be detected by the pressure in a master cylinder 48, or the treading-in stroke of a brake pedal 47.

[0050] Moreover, the signal which shows the signal and the throttle opening T_a (the amount of driving force control operation by the operator) which show an engine speed N_e from an engine control system 26 to an electronic control 50 is inputted, and the signal which shows the steering angle θ (the amount of steering control operation by the operator) through the rudder angle control unit 62 from the steering angle sensor 82 is inputted. In addition, the amount of driving force control operation by the operator may be detected by the treading-in stroke of an accelerator pedal.

[0051] In addition, the order acceleration sensor 74 makes the acceleration direction of a vehicle forward, order acceleration is detected, and the lateral acceleration sensor 76 and the steering angle sensor 82 detect lateral acceleration etc. by making the anticlockwise rotation direction of a vehicle forward. Moreover, the engine control system 26, the electronic control 50, and the rudder angle control unit 62 may consist of the microcomputers and drive circuits which contain CPU, ROM, RAM, and an I/O device, for example, respectively in fact.

[0052] The electronic control 50 for behavior control follows the routine shown in drawing 2 so that it may explain to a detail later. It is first based on the vehicle speed V_x etc. as a target movement quantity of state of a vehicle Target yaw rate γ_{mat} of a vehicle, The target lateral acceleration G_{yt} of a vehicle and the target order acceleration G_{xt} of a vehicle are calculated. The target order force F_{xt} of the vehicle corresponding to [as an amount of target internal states of a vehicle] the target order acceleration G_{xt} of a vehicle based on these, Target slip-angle β_{at} of the target lateral force F_{yt} of the vehicle corresponding to the target lateral acceleration G_{yt} , the target yaw moment M_t of the vehicle corresponding to target yaw rate γ_{mat} , and a vehicle is calculated.

[0053] Moreover, the electronic control 50 for behavior control is based on the vehicle order acceleration G_x etc., and is the normal load F_{zi} ($i=f, r, l$) of each wheel. Calculate f_r , r_l , and r_r and the target generating force F_{xyt} of a vehicle is calculated as resultant force of the target order force F_{xt} of a vehicle, and the target lateral force F_{yt} of a vehicle. By distributing the target generating force F_{xyt} of a vehicle to each wheel according to the normal load F_{zi} of each wheel First target generating force F_{xyti} ($i=f, r, l, r$) of each wheel which attains the target order force F_{xt} of a vehicle and the target lateral force F_{yt} of a vehicle is calculated as force of a direction of meeting in the direction of the target generating force F_{xyt} of a vehicle.

[0054] The electronic control 50 for behavior control the target generating force F_{xyti} of each wheel by moreover, the control law made strictly in agreement in the direction of the target generating force F_{xyt} of a vehicle The amount of amendments of the target generating force of each wheel for attaining only the target yaw moment M_t of a vehicle, That is, second target generating force ΔF_{xyti} ($i=f, r, l, r$) of each wheel is calculated, and the target generating force F_{xyti} of each wheel ($i=f, r, l, r$) is calculated as the sum of first target generating force F_{xyti} and second target generating force ΔF_{xyti} .

[0055] Furthermore, target rudder angle δ_{tati} of each wheel for the electronic control 50 for behavior control to make the generating force of each wheel the target generating force F_{xyti} , The target wheel order force F_{wxti} in the wheel coordinate of each wheel, target slip ratio Sti ($i=f, r, l, r$) of each wheel Calculate f_r , r_l , and r_r and target running torque T_{wti} of each wheel is calculated based on the target wheel order force F_{wxti} and the target slip ratio Sti of each wheel. It is based on target running torque T_{wti} of each wheel, and is the target braking pressure P_{ti} ($i=f, r, l, r$) of each wheel. f_r , r_l , r_r , and the target driving torque T_{et} of an engine 10 are calculated. While outputting a command signal to the rudder angle control device 62 and an engine control system 26 so that rudder angle δ_{tai} of each wheel may turn into target rudder angle δ_{tati} and the output torque of an engine 10 may turn into the target driving torque T_{et} , a damping device 42 is controlled so that the braking pressure P_i of each wheel turns into the target braking pressure P_{ti} .

[0056] Next, with reference to the flow chart shown in drawing 2 thru/or drawing 5, the transit control routine of the vehicle in the first operation gestalt is explained. In addition, closing of the ignition switch which is not shown in drawing begins, and control by the main routine of the flow chart shown in drawing 2 is repeatedly performed for every predetermined time amount.

[0057] Reading of the signal which shows the vehicle speed V_x first detected by the speed sensor 72 in step 50 is performed, and the target lateral acceleration G_{yt} of target yaw rate γ_{mat} of a vehicle and a vehicle and the target order acceleration G_{xt} of a vehicle

calculate as a target movement quantity of state of a vehicle based on the vehicle speed V_x etc. in step 100.

[0058] For example, target yaw rate γ sets a steering gear ratio to N , and sets the wheel base of a vehicle to L . It calculates according to the following formula 1, setting a stability factor to K_h and using a steering-yaw rate transient transfer function as $H(s)$. The target lateral acceleration G_{yt} sets a yaw rate-lateral acceleration transient transfer function to $G(s)$, and calculates it by the following formula 2. The target order acceleration G_{xt} Engine-speed N_e , the throttle opening T_a According to the following formula 3, it calculates with the function F for calculating the target order acceleration of a vehicle by making the treading strength F_b to gear ratio R_d of the drive system based on the shift position P_s of transmission 16, and a brake pedal into a variate (N_e , T_a , R_d , F_b).

[0059]

$$\gamma = \theta - V_x / \{N \cdot L (1 + K_h \cdot V_x^2)\} H(s) \dots (1)$$

$$G_{yt} = \gamma \cdot t - V_x - G(s) \dots (2)$$

$$G_{xt} = F(N_e, T_a, R_d, F_b) \dots (3)$$

[0060] In step 150, target slip-angle β of the target order force F_{xt} of the vehicle corresponding to the target order acceleration G_{xt} of a vehicle, the target lateral force F_{yt} of the vehicle corresponding to the target lateral acceleration G_{yt} , the target yaw moment M_t of the vehicle corresponding to target yaw rate γ , and a vehicle calculates as an amount of target internal states of a vehicle.

[0061] Especially the target order force F_{xt} and the target lateral force F_{yt} of a vehicle are calculated according to the following formulas 4 and 5, respectively by setting mass of a vehicle to M_v , the target yaw moment M_t sets yaw moment of inertia of a vehicle to I_y , and calculates it according to the following formula 6 by setting the differential value of target yaw rate γ of a vehicle to $\dot{\gamma}$, and target slip-angle β of a vehicle calculates it according to the following formula 7.

$$F_{xt} = M_v \cdot G_{xt} \dots (4)$$

$$F_{yt} = M_v \cdot G_{yt} \dots (5)$$

$$M_t = I_y \cdot \dot{\gamma} \dots (6)$$

$$\beta = \int (G_{yt} / V_x - \gamma) dt \dots (7)$$

[0063] Distance of the vehicle cross direction between the center of gravity 90 of a vehicle 12 and a front-wheel axle is set to L_f as step 200 is shown in drawing 8 and drawing 11. Set distance of the vehicle cross direction between the center of gravity of a vehicle, and a rear wheel axle to L_r , and the center-of-gravity height of a vehicle is set to H . According to the following formulas 8-11, the touch-down load F_{zi} ($i=f, r, l, r$) of each wheel calculates, respectively, setting roll rigidity allocation of a front wheel and a rear wheel to R_f and R_r ($R_f + R_r = 1$), respectively, setting the tread of a vehicle to T_r , and using gravitational acceleration as g . In addition, the order acceleration G_x and lateral acceleration G_y in the following formulas 8-11 may be the value presumed based on the vehicle speed V_x etc. or the target order acceleration G_{xt} , and the target lateral acceleration G_{yt} .

[0064]

$$F_{zf} = M_v \{ (g \cdot L_r - G_x \cdot H) / (2L) - G_y \cdot H \cdot R_f / T_r \}$$

.... (8)

$$F_{zfr} = M_v \{ (g \cdot L_r - G_x \cdot H) / (2L) + G_y \cdot H \cdot R_f / T_r \}$$

.... (9)

$$F_{zrl} = M_v \{ (g \cdot L_f + G_x \cdot H) / (2L) - G_y \cdot H \cdot R_r / T_r \}$$

.... (10)

$$F_{zrr} = M_v \{ (g \cdot L_f + G_x \cdot H) / (2L) + G_y \cdot H \cdot R_r / T_r \}$$

.... (11)

[0065] While the target generating force F_{xyt} of a vehicle calculates according to the following formula 12 in step 250 as resultant force of the target order force F_{xt} of a vehicle, and the target lateral force F_{yt} Since the following formula 13 is materialized, according to the following formulas 14-17, the target generating force of each wheel of attaining the target generating force F_{xyt} of a vehicle, i.e., first target generating force F_{xyt0i} of each wheel, ($i=f, r, l, r$) calculates, without giving the target yaw moment M_t to a vehicle.

[0066]

$$F_{xyt} = (F_{xt}^2 + F_{yt}^2)^{1/2} \dots (12)$$

$$F_{zf} + F_{zfr} + F_{zrl} + F_{zrr} = M_v \cdot g \dots (13)$$

$$F_{xyt0f} = F_{xyt} \cdot F_{zf} / (M_v \cdot g) \dots (14)$$

$$F_{xyt0fr} = F_{xyt} \cdot F_{zfr} / (M_v \cdot g) \dots (15)$$

$$F_{xyt0rl} = F_{xyt} \cdot F_{zrl} / (M_v \cdot g) \dots (16)$$

$$F_{xyt0rr} = F_{xyt} \cdot F_{zrr} / (M_v \cdot g) \dots (17)$$

[0067] In this case, they are F_{xt0i} and F_{yt0i} ($i=f, l$), respectively about the component of the vehicle cross direction of target generating force F_{xyt0i} of each wheel which attains the target generating force F_{xyt} of a vehicle, and the component of a vehicle longitudinal direction. If it is referred to as f_r , l_r , and r_r , the sum total of the component of the vehicle longitudinal direction of a right-and-left front wheel and a right-and-left rear wheel is set to F_{yt0f} and F_{yt0r} , respectively and the sum total of the component of the vehicle cross direction of a forward left rear wheel and a forward right rear wheel is set to F_{xt0L} and F_{xt0R} , respectively The force of these sum totals is expressed by the following formulas 18-21, respectively.

[0068]

$$F_{yt0} = F_{yt0f} + F_{yt0r} \dots (18)$$

$$F_{xt0} = F_{xt0l} + F_{xt0r} \dots (19)$$

$$F_{xt0L} = F_{xt0f} + F_{xt0rl} \dots (20)$$

$$F_{xt0R} = F_{xt0fr} + F_{xt0rr} \dots (21)$$

[0069] Moreover, the touch-down load of a right-and-left front wheel is set to F_{zf} , the touch-down load of a right-and-left rear wheel is set to F_{zr} , the touch-down load of a forward left rear wheel is set to F_{zL} , and total force F_{yt0f} , F_{yt0r} , F_{xt0L} , and F_{xt0R} are expressed by the following formulas 22-25, respectively by setting the touch-down load of a forward right rear wheel to F_{zR} .

$$F_{yt0f} = F_{zf} \cdot G_{yt} / g \dots (22)$$

$$F_{yt0r} = F_{zr} \cdot G_{yt} / g \dots (23)$$

$$F_{xt0L} = F_{zL} \cdot G_{xt} / g \dots (24)$$

$$F_{xt0R} = F_{zR} \cdot G_{xt} / g \dots (25)$$

[0070] In addition, the touch-down load F_{zf} of the right-and-left front wheel in each above-mentioned formula, the touch-down load F_{zr} of a right-and-left rear wheel, the touch-down load F_{zL} of a forward left rear wheel, and the touch-down load F_{zR} of a forward right rear wheel are expressed by the following formulas 26-29, respectively.

[0071]

$$F_{zf} = F_{zf} + F_{zfr} = M_v \cdot g - L_r / L \cdot M_v \cdot G_x - H / L \dots (26)$$

$$Fzr=Fzrl+Fzrr=Mv-g-Lf/L+Mv-Gx-H/L \dots (27)$$

$$FzL=Fzfl+Fzrl=Mv-g/2-Mv-Gy-H/Tr \dots (28)$$

$$FzR=Fzfr+Fzrr=Mv-g/2+Mv-Gy-H/Tr \dots (29)$$

[0072] Furthermore, if the target yaw moment M_t of a vehicle is calculated by the following formula 30 and the above-mentioned formulas 22-25 and formulas 26-29 are substituted for this formula 30, the right-hand side of a formula 30 will be set to 0. Therefore, it turns out that first target generating force F_{xyt0i} of each wheel called for by the 14 to formula 17 above-mentioned formula does not give the yaw moment to a vehicle.

$$M_t = I_y - \gamma \text{td} \text{Tr} / [= Lf \cdot F_{yt0f} - Lr \cdot F_{yt0r} + (F_{xt0L} - F_{xt0R}) \text{ and }] 2 \dots (30)$$

[0073] By the control law which makes the target generating force F_{xyti} of each wheel strictly in agreement in the direction of the target generating force F_{xyt} of a vehicle according to the routine shown in below-mentioned drawing 3 in step 300, the amount of amendments of the target generating force of each wheel for attaining only the target yaw moment M_t of a vehicle, i.e., second target generating force ΔF_{xyti} of each wheel, ($i=fl, fr, rl, rr$) calculates.

[0074] The target generating force F_{xyti} of each wheel ($i=fl, fr, rl, rr$) calculates as the sum of first target generating force F_{xyt0i} of each wheel calculated in step 250 according to the following formula 24 in step 350, and second target generating force ΔF_{xyti} of each wheel calculated in step 300.

$$F_{xyti} = F_{xyt0i} + \Delta F_{xyti} \dots (31)$$

[0075] According to the routine shown in below-mentioned drawing 4 in step 600, the target wheel order force F_{wxti} in target rudder angle $\Delta tati$ of each wheel and the wheel coordinate of each wheel and the target slip ratio Sti ($i=fl, fr, rl, rr$) of each wheel calculate.

[0076] According to the routine shown in below-mentioned drawing 5 in step 700, the target braking pressure P_{ti} of each wheel and the target driving torque T_{et} of an engine 10 calculate. In step 800, rudder angle $\Delta tati$ of each wheel turns into target rudder angle $\Delta tati$. A command signal is outputted to the rudder angle control device 62 and an engine control system 26 so that the output torque of an engine 10 may turn into the target driving torque T_{et} . Moreover, it is controlled by the target generating force F_{xyti} in which the generating force of each wheel corresponds by controlling a damping device 42, respectively so that the braking pressure P_i of each wheel turns into the target braking pressure P_{ti} , and it returns to step 50 after an appropriate time.

[0077] In step 310 of the second target generating force ΔF_{xyti} operation routine of each wheel shown in drawing 3 It is D_i ($i=fl$) in the arm length of each yaw moment given to a vehicle 12 by first target generating force F_{xyt0i} of each wheel calculated in the above-mentioned step 250 around the center of gravity 90 of opposite *Perilla frutescens* (L.) Britton var. *crispa* (Thunb.) Decne. as shown in drawing 8. fr, rl , and rr calculate according to the following formulas 32-35.

$$D_{fl} = |F_{yt0fl} - Tr/2 + F_{xt0fl} - Lf| \dots (32)$$

$$D_{fr} = |F_{yt0fr} - Tr/2 + F_{xt0fr} - Lf| \dots (33)$$

$$D_{rl} = |F_{yt0rl} - Tr/2 - F_{xt0rl} - Lr| \dots (34)$$

$$D_{rr} = |F_{yt0rr} - Tr/2 - F_{xt0rr} - Lr| \dots (35)$$

[0079] In addition, in drawing 8 and below-mentioned drawing 11, the circle shown centering on the grounding point P_{zi} ($i=fl, fr, rl, rr$) of each wheel shows the size relation of the touch-down load F_{zi} of each wheel, therefore the size relation of a friction circle.

[0080] Second target generating force ΔF_{xytfl} of the right-and-left front wheel for attaining only the target yaw moment M_t of a vehicle in step 320, Since the following formula 36 will be materialized supposing it sets the sum total of the sum total of ΔF_{xytfr} and second target generating force ΔF_{xytrl} of a right-and-left rear wheel, and ΔF_{xyt} and total force ΔF_{xyt} is distributed according to the touch-down load of a wheel on either side **** km of force ΔF_{xyt} of the sum total in the third formula of the right-hand side of a formula 36 calculates according to the following formula 37.

[0081]

$$M_t = I_y - \gamma \text{td} = \{ (F_{zfl} - D_{fl} + F_{zfr} - D_{fr}) / (F_{zfl} + F_{zfr}) \} \text{ and } \Delta F_{xyt} + (F_{zrl} - D_{rl} + F_{zrr} - D_{rr}) / (F_{zrl} + F_{zrr}) - \Delta F_{xyt} = \{ (F_{zfl} - D_{fl} + F_{zfr} - D_{fr}) / (F_{zfl} + F_{zfr}) + (F_{zrl} - D_{rl} + F_{zrr} - D_{rr}) / (F_{zrl} + F_{zrr}) \} - \Delta F_{xyt} \dots (36)$$

$$K_m = (F_{zfl} - D_{fl} + F_{zfr} - D_{fr}) / (F_{zfl} + F_{zfr}) + (F_{zrl} - D_{rl} + F_{zrr} - D_{rr}) / (F_{zrl} + F_{zrr}) \dots (37)$$

[0082] Second target generating force ΔF_{xyti} ($i=fl, fr, rl, rr$) of each wheel for attaining only the target yaw moment M_t of a vehicle according to the following formulas 38-41 in step 330 calculates.

[0083]

$$\Delta F_{xytfl} = \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} - \Delta F_{xyt} = \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \text{ and } I_y - \gamma \text{td} / K_m \dots (38)$$

$$\Delta F_{xytfr} = \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} - \Delta F_{xyt} = \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \text{ and } I_y - \gamma \text{td} / K_m \dots (39)$$

$$\Delta F_{xytrl} = - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} - \Delta F_{xyt} = - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \text{ and } I_y - \gamma \text{td} / K_m \dots (40)$$

$$\Delta F_{xytrr} = - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} - \Delta F_{xyt} = - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \text{ and } I_y - \gamma \text{td} / K_m \dots (41)$$

[0084] In step 610 of target rudder angle $\Delta tati$ of each wheel shown in drawing 4, the target wheel order force F_{wxti} of each wheel, and the target slip ratio Sti operation routine of each wheel, target advance vectorial angle α_{hawti} ($i=fl, fr, rl, rr$) of the grounding point of each wheel calculates according to the following formulas 42-45. In addition, target advance vectorial angle α_{hawti} of a grounding point is an include angle which the target travelling direction of the grounding point P_{zi} of each wheel makes to the cross direction of a vehicle as the forward left ring is shown in drawing 9.

[0085]

$$\alpha_{hawtfl} = (\text{betat} - V_x + Lf - \gamma \text{td}) / (V_x - Tr - \gamma \text{td} / 2) \dots (42)$$

$$\alpha_{hawtfr} = (\text{betat} - V_x + Lf - \gamma \text{td}) / (V_x + Tr - \gamma \text{td} / 2) \dots (43)$$

$$\alpha_{hawtrl} = (\text{betat} - V_x - Lr - \gamma \text{td}) / (V_x - Tr - \gamma \text{td} / 2) \dots (44)$$

$$\alpha_{hawtrr} = (\text{betat} - V_x - Lr - \gamma \text{td}) / (V_x + Tr - \gamma \text{td} / 2) \dots (45)$$

[0086] In step 620, the target touch-down load F_{zti} of each wheel ($i=fl, fr, rl, rr$) calculates based on the target order acceleration G_{xt} and the target lateral acceleration G_{yt} of a vehicle according to the following formulas 46-49 corresponding to the above-mentioned formulas 8-11, respectively.

[0087]

$$F_{ztf} = M_v \{ (g - Lr - G_{xt} - H) / (2L) - G_{yt} - H - Rf / Tr \} \dots (46)$$

$$F_{ztr} = M_v \{ (g - Lr - G_{xt} - H) / (2L) + G_{yt} - H - Rf / Tr \} \dots (47)$$

$$F_{ztl} = M_v \{ (g - Lf + G_{xt} - H) / (2L) - G_{yt} - H - Rr / Tr \} \dots (48)$$

$$F_{ztr} = M_v \{ (g - Lf + G_{xt} - H) / (2L) + G_{yt} - H - Rr / Tr \} \dots (49)$$

[0088] The value F_{wxti} by which the target generating force F_{xyti} of each wheel was decomposed into the target order force and target lateral force in the wheel coordinate of each wheel, i.e., the target wheel order force, and the target wheel lateral force F_{wyti} ($i=fl, fr, rl, rr$) calculate according to the following formulas 50 and 51, respectively as the forward left ring is shown in drawing 10 in step 630.

[0089]

$$F_{wxti} = F_{xyti} \cdot \cos(\pi/2 - \text{deltati})$$

$$= F_{xyti} \cdot \sin \text{deltati} \dots (50)$$

$$F_{wyti} = F_{xyti} \cdot \sin(\pi/2 - \text{deltati})$$

$$= F_{xyti} \cdot \cos \text{deltati} \dots (51)$$

[0090] In step 640, target slip-angle betawti ($i=fl, fr, rl, rr$) of each wheel calculates according to the following formula 52 as the sum of grounding point target travelling direction angle α_{wti} of each wheel, and target rudder angle deltati .

$$\text{betawti} = \alpha_{wti} + \text{deltati} \dots (52)$$

[0091] In step 650, the lateral-force generating forecast F_{wyai} and the target slip ratio Sti ($i=fl, fr, rl, rr$) of each wheel calculate by the operation expression based on the tire generating force map or tire model which is not shown in drawing based on the target wheel order force F_{wxti} of each wheel, target slip-angle betawti of each wheel, and the target touch-down load F_{zti} of each wheel.

[0092] In step 660, deflection deltaFwyi ($i=fl, fr, rl, rr$) of the target wheel lateral force F_{wyti} and the lateral-force generating forecast F_{wyai} calculates about each wheel according to the following formula 53.

$$\text{deltaFwyi} = F_{wyti} - F_{wyai} \dots (53)$$

[0093] Steps 670-690 are performed about each wheel in order of for example, a forward left ring, a forward right ring, a left rear ring, and a right rear ring. Distinction of whether especially in the step 670, the absolute value of deflection deltaFwyi of wheel lateral force is under reference-value deltaFwyo (forward constant), That is, when distinction with unnecessary correction of target rudder angle deltati is performed and negative distinction is performed, it progresses to step 680, and when affirmation distinction is performed, it progresses to the back step 700 at which target rudder angle deltati was set as the value last time in step 675.

[0094] In step 680, the amount deltadeltati of corrections of the target rudder angle of each wheel ($i=fl, fr, rl, rr$) calculates K_s according to the following formula 54 as a forward constant, and in step 690, target rudder angle deltati ($i=fl, fr, rl, rr$) of each wheel is corrected to $\text{deltati} + \text{deltadeltati}$, and returns to step 630 after an appropriate time.

$$\text{Deltadeltati} = K_s \cdot \text{deltaFwyi} \dots (54)$$

[0095] In the target braking pressure P_{ti} of each wheel shown in drawing 5, and step 710 of an engine target driving torque T_{et} operation routine, while the target longitudinal velocity V_{wxti} of the grounding point of each wheel ($i=fl, fr, rl, rr$) calculates according to the following formulas 55-58, according to the following formula 59, the target passing speed V_{twti} of the rolling direction of each wheel ($i=fl, fr, rl, rr$) calculates.

[0096]

$$V_{wxtfl} = V_x + Tr \cdot \gamma / 2 \dots (55)$$

$$V_{wxtfr} = V_x - Tr \cdot \gamma / 2 \dots (56)$$

$$V_{wxtlr} = V_{wxtfl} \dots (57)$$

$$V_{wxttr} = V_{wxtfr} \dots (58)$$

$$V_{twti} = V_{wxti} \cdot (\cos \text{deltati} - \tan \text{betawti} \cdot \sin \text{deltati}) \dots (59)$$

[0097] In step 720, V_{rwti} ($i=fl, fr, rl, rr$) calculates whenever [target wheel speed / of each wheel] according to the following formula 60 based on the target slip ratio Sti and the target passing speed V_{rwti} of the rolling direction.

$$V_{rwti} = (1 - \text{Sti}) \cdot V_{twti} \dots (60)$$

[0098] While the target wheel acceleration V_{rwtdi} of each wheel ($i=fl, fr, rl, rr$) calculates as a time amount differential value of V_{rwti} whenever [target wheel speed] in step 730, the effective radius of a wheel is set to R_w and target running torque T_{wti} ($i=fl, fr, rl, rr$) of each wheel calculates according to the following formula 61 by setting the rotational inertia moment of a wheel to I_w .

$$T_{wti} = F_{wxti} \cdot R_w + I_w \cdot V_{rwtdi} \dots (61)$$

[0099] When distinction of whether target running torque T_{wti} of all wheels is a negative value, i.e., distinction of whether to be in a situation [wheels / all] to be braked, is performed in step 740 and affirmation distinction is performed, it progresses to step 770, and when negative distinction is performed, it progresses to step 750.

[0100] While the gear ratio R_d of a drive system is called for based on the shift position P_s in step 750 It is X_i ($i=fl$) about the rate of allocation of the driving torque of the engine 10 to each wheel by the drive system. It is referred to as fr, rl , and rr ($0 < X_i < 0.5$, $\sigma X_i = 1$), and maximum of the target running torque $T_{wti}(s)$ of four flowers is set to T_{wtmax} . The target driving torque T_{et} of an engine 10 calculates according to the following formula 62 by setting to X_{max} the rate of driving torque allocation of the wheel (the maximum driving torque wheel) whose target running torque is Maximum T_{wtmax} .

$$T_{et} = T_{wtmax} \cdot R_d / X_{max} \dots (62)$$

[0101] While the target braking pressure P_{ti} of the maximum driving torque wheel is set as 0 in step 760, by setting the transform coefficient of braking pressure and damping torque to K_p , the target braking pressure P_{ti} of each wheel other than the maximum driving torque wheel calculates according to the following formula 63, and progresses to step 800 after an appropriate time.

$$P_{ti} = (T_{wtmax} - X_i / X_{max} \cdot T_{wti}) / K_p \dots (63)$$

[0102] In step 770, it is set as 0, the target braking pressure P_{ti} of each wheel calculates according to the following formula 64 in step 780, and the target driving torque T_{et} of an engine 10 progresses to step 800 after an appropriate time.

$$P_{ti} = -T_{wti} / K_p \dots (64)$$

[0103] According to the first operation gestalt of illustration, in step 100, it is based on the vehicle speed V_x etc. in this way. As a target movement quantity of state of a vehicle Target yaw rate γ_{mat} of a vehicle, The target lateral acceleration G_{yt} of a vehicle and the target order acceleration G_{xt} of a vehicle calculate. The target order force F_{xt} of the vehicle on step 150 and corresponding to the target order acceleration G_{xt} of a vehicle as an amount of target internal states of a vehicle, Target slip-angle betat of the target lateral force F_{yt} of the vehicle corresponding to the target lateral acceleration G_{yt} , the target yaw moment M_t of the vehicle corresponding to target yaw rate γ_{mat} , and a vehicle calculates.

[0104] Moreover, while the normal load F_{zti} of each wheel calculates in step 200 and the target generating force F_{xyt} of a vehicle calculates in step 250 as resultant force of the target order force F_{xt} of a vehicle, and the target lateral force F_{yt} First target generating force F_{xyt0i} of each wheel which attains the target generating force F_{xyt} of a vehicle, without giving the yaw moment to a vehicle calculates. By the control law which makes the target generating force F_{xyti} of each wheel strictly in agreement in the direction of the target generating force F_{xyt} of a vehicle in step 300 Second target generating force deltaFxyti of each wheel for attaining only the target yaw moment M_t of a vehicle calculates, and the target generating force F_{xyti} of each wheel calculates in step 350 as the sum of first target generating force F_{xyt0i} and second target generating force deltaFxyti .

[0105] Therefore, according to the first operation gestalt of illustration, so that the target order force F_{xt} , the target lateral force F_{yt} , and the target yaw moment M_t of a vehicle may be attained certainly So that the target lateral acceleration G_{yt} of target yaw rate γ of a vehicle and a vehicle and the target order acceleration G_{xt} of a vehicle may be attained certainly, if it puts in another way The amount of steering control operation can calculate the target generating force F_{xyti} of each wheel, and according to an operator by this (steering angle θ), It can be made to run a vehicle stably in the state of movement of the request according to the amount of driving force control operation (throttle opening T_a), and the amount of braking control operation (brake-pedal treading strength F_b).

[0106] Moreover, since the direction of the target generating force F_{xyti} of all wheels can be completely adjusted in the direction of the target generating force F_{xyt} of a vehicle, it can prevent certainly that a part of force which each wheel generates acts on the car body of a vehicle 12 vainly as internal stress, and can be made to run a vehicle stably, using most efficiently the force which each wheel generates by this.

[0107] Moreover, target rudder angle δ_{tati} of each wheel which attains the target generating force F_{xyti} of each wheel in step 600 according to the first operation gestalt of illustration, The target wheel order force F_{wxti} in the wheel coordinate of each wheel and the target slip ratio Sti of each wheel calculate. In step 700, the target braking pressure P_{ti} of each wheel and the engine target driving torque T_{et} calculate. In step 800, rudder angle δ_{tati} of each wheel turns into target rudder angle δ_{tati} . A command signal is outputted to the rudder angle control device 62 and an engine control system 26 so that the output torque of an engine 10 may turn into the target driving torque T_{et} . Moreover, the generating force of each wheel is controlled by the target generating force F_{xyti} of corresponding, respectively, by controlling a damping device 42 so that the braking pressure P_i of each wheel turns into the target braking pressure P_{ti} .

[0108] Therefore, since according to the first operation gestalt of illustration the rudder angle and braking/driving force of each wheel are controlled so that the generating force of each wheel turns into the target generating force F_{xyti} of corresponding, respectively In the case of the conventional transit control unit by which only the braking/driving force of a wheel is controlled, it compares. The magnitude of the generating force of each wheel and the control range of a direction can be expanded, the engine performance of a wheel (tire) can be used effectively, and, thereby, the generating force of each wheel can be certainly controlled in the target generating force F_{xyti} of corresponding.

[0109] Moreover, by carrying out feedforward control of the rudder angle and braking/driving force of each wheel so that the generating force of each wheel may turn into the target generating force F_{xyti} of corresponding, respectively, like **** according to the first operation gestalt of illustration Since the vehicle order acceleration G_x , lateral acceleration G_y , and the yaw rate γ are controlled by the target order acceleration G_{xt} of a vehicle, the target lateral acceleration G_{yt} , and target yaw rate γ , respectively In the case of the conventional common transit control unit with which the braking/driving force of each wheel is controlled by feedback control according to an individual so that this deflection becomes small based on the deflection of the target behavior index value of a vehicle, and the actual behavior index value of a vehicle, it compares. Transit movement of a vehicle can be controlled according to the operation by the operator certainly and effectively, without producing problems, such as response delay and hunting.

[0110] Target rudder angle δ_{tati} of each wheel for making the generating force of each wheel into the target generating force F_{xyti} in step 600 especially according to the first operation gestalt of illustration, The target wheel order force F_{wxti} in the wheel coordinate of each wheel and the target slip ratio Sti of each wheel calculate. While V_{rwti} calculates whenever [target wheel speed / of each wheel] based on the target slip ratio Sti in steps 710 and 720 and the target wheel acceleration V_{rwdti} of each wheel calculates in step 730 Since target running torque T_{wti} of each wheel calculates based on the target wheel order force F_{wxti} of each wheel, and the target wheel acceleration V_{rwdti} As compared with the case where the target wheel acceleration V_{rwdti} calculated based on the target slip ratio Sti of each wheel is not taken into consideration, target running torque T_{wti} of each wheel can be calculated correctly.

[0111] Moreover, according to the first operation gestalt of illustration, based on the maximum T_{wtmax} of a driving side, the target driving torque T_{et} of the engine 10 as a driving source calculates among target running torque $T_{wti}(s)$ of each wheel. Since the target braking pressure P_{ti} calculates based on target running torque T_{wti} of Maximum T_{wtmax} and other wheels about other wheels other than the wheel whose target running torque is max While controlling an engine 10 so that the driving torque turns into the target driving torque T_{et} , the generating force of each wheel is certainly [easily and] controllable in the target generating force F_{xyti} by controlling the braking pressure P_i of a wheel besides the above to the target braking pressure P_{ti} .

[0112] Moreover, according to the first operation gestalt of illustration, in step 660, deflection δ_{Fwyti} of the target wheel lateral force F_{wyti} and the lateral-force generating forecast F_{wyati} calculates. When the magnitude of deflection δ_{Fwyti} of the target wheel lateral force F_{wyti} and the lateral-force generating forecast F_{wyati} is under a reference value in steps 670-690 Target rudder angle δ_{tati} of the wheel concerned is set as the last target rudder angle, and when the magnitude of deflection δ_{Fwyti} of the target wheel lateral force F_{wyti} and the lateral-force generating forecast F_{wyati} is beyond a reference value Since the value from which the last target rudder angle was corrected in the amount $\delta_{tadeltati}$ of target rudder angle corrections is set as target rudder angle δ_{tati} of the wheel concerned while the amount $\delta_{tadeltati}$ of target rudder angle corrections calculates based on deflection δ_{Fwyti} , it can calculate certainly, without making target rudder angle δ_{tati} of each wheel emit.

[0113] The second operation gestalt drawing 6 is a flow chart which shows the main routine of rudder angle control of each wheel in the second operation gestalt of the transit control device of the four-flower vehicle by this invention, and braking/driving force control. In addition, in drawing 6, the same step number as the step number attached in drawing 2 is given to the step corresponding to the step shown in drawing 2.

[0114] Steps 50-250 and steps 600-800 of this operation gestalt are performed like the first above-mentioned operation gestalt. By the control law which distributes the target generating force F_{xyt} of a vehicle in proportion to the touch-down load of each wheel strictly according to the routine shown in drawing 7 in step 400 performed by the degree of step 250 The correction factor K_r to the resultant force F_m of the generating force (second target generating force) of each wheel for attaining only the target yaw moment M_t of a vehicle, the target basic generating force F_{bxyti} of each wheel ($i=f_l, f_r, r_l, r_r$), and the target basic generating force of each wheel calculates.

[0115] In step 550, the target generating force F_{xyti} of each wheel calculates as a product of a correction factor K_r and the target basic generating force F_{bxyti} according to the following formula 65, and progresses to step 600 after an appropriate time.

$$F_{xyti} = K_r \cdot F_{bxyti} \dots (65)$$

[0116] In step 410 of the resultant force F_m of the second target generating force of each wheel shown in drawing 7, the target basic generating force F_{bxyti} of a vehicle, and a correction factor K_r operation routine Distinction of whether the product of the vehicle order acceleration G_x and the lateral acceleration G_y of a vehicle is 0, That is, when distinction of whether the vehicle order acceleration G_x or the lateral acceleration G_y of a vehicle is 0 is performed and negative distinction is performed, it progresses to step 450, and when affirmation distinction is performed, it progresses to step 420.

[0117] So that the wheel which attains the target yaw moment M_t of a vehicle by vector rotation of the wheel generating force in step

420 may be specified as a right-and-left front wheel and a right-and-left rear wheel While j which shows the wheel by which vector rotation of the wheel generating force is carried out is set as fl, fr, rl, and rr Include-angle thetaji (j=fl, fr, rl, rr) which the vector of target generating force Fxyt0i of each wheel makes to the segment which connects the grounding point Pzi of each wheel and the center of gravity 90 of a vehicle as the case where j is fr and rl is shown in drawing 11 calculates according to the following formulas 66-69.

[0118]

$$\text{thetafl} = \tan^{-1} |F_{xt0\ fl} / F_{yt0\ fl}| - \tan^{-1} |2\ Lf / Tr| \dots (66)$$

$$\text{thetafr} = \tan^{-1} |F_{xt0\ fr} / F_{yt0\ fr}| - \tan^{-1} |2\ Lf / Tr| \dots (67)$$

$$\text{thetarl} = \tan^{-1} |F_{xt0\ rl} / F_{yt0\ rl}| - \tan^{-1} |2\ Lr / Tr| \dots (68)$$

$$\text{thetarr} = \tan^{-1} |F_{xt0\ rr} / F_{yt0\ rr}| - \tan^{-1} |2\ Lr / Tr| \dots (69)$$

[0119] The resultant force Fm for generating only the target yaw moment Mt of a vehicle according to the following formula 70 in step 430, i.e., the resultant force of the second target generating force of four flowers specified in step 420, calculates.

[0120]

[Equation 1]

$$F_m = I_y \cdot \gamma_t / \sum_{i=j} \cos \theta_i \dots (70)$$

[0121] In step 440, the target basic generating force Fbxyti of each wheel (i=fl, fr, rl, rr) calculates according to the following formulas 71-74.

$$F_{bxytfl} = (F_{xyt0fl} + F_m) / 2 \dots (71)$$

$$F_{bxytfr} = (F_{xyt0fr} + F_m) / 2 \dots (72)$$

$$F_{bxytrl} = (F_{xyt0rl} + F_m) / 2 \dots (73)$$

$$F_{bxytrr} = (F_{xyt0rr} + F_m) / 2 \dots (74)$$

[0122] When distinction of whether the product of the vehicle order acceleration Gx and the lateral acceleration Gy of a vehicle is a forward value is performed in step 450 and negative distinction is performed, it progresses to step 490, and when affirmation distinction is performed, it progresses to step 460. In addition, the vehicle order acceleration used for the product of steps 410 and 450 and lateral acceleration may be values presumed based on the vehicle speed Vx etc., and may be the target order acceleration Gxt and the target lateral acceleration Gyt.

[0123] So that the wheel which attains the target yaw moment Mt of a vehicle by vector rotation of the wheel generating force in step 460 may be specified as a forward left ring and a right rear ring While j which shows the wheel by which vector rotation of the wheel generating force is carried out is set as fl and rr and k which shows the wheel by which vector rotation of the wheel generating force is not carried out is set as fr and rl Include-angle thetaji (j=fl, rr) which the vector of target generating force Fxyt0fl of a forward left ring and a right rear ring and Fxyt0rr makes to the segment which connects the grounding points Pzfl and Pzrr of a forward left ring and a right rear ring and the center of gravity 90 of a vehicle calculates according to the above-mentioned formulas 66 and 69.

[0124] Resultant force of the second target generating force of the resultant force Fm for generating the target yaw moment Mt of a vehicle according to the above-mentioned formula 70 in step 470, i.e., a forward left ring, and a right rear ring calculates, and the target basic generating force Fbxyti of each wheel calculates according to the following formulas 75-78 in step 480.

[0125]

$$F_{bxytfl} = (F_{xyt0fl} + F_m) / 2 \dots (75)$$

$$F_{bxytfr} = F_{xyt0fr} \dots (76)$$

$$F_{bxytrl} = F_{xyt0rl} \dots (77)$$

$$F_{bxytrr} = (F_{xyt0rr} + F_m) / 2 \dots (78)$$

[0126] While j is set as fr and rl and k is set as fl and rr so that the wheel which attains the target yaw moment Mt of a vehicle by vector rotation of the generating force of a wheel in step 490 may be specified as a forward right ring and a left rear ring Include-angle thetaji which the vector of target generating force Fxyt0fr of a forward right ring and a left rear ring and Fxyt0rl makes to the segment which connects the grounding points Pzfr and Pzrl of a forward right ring and a left rear ring, and the center of gravity 90 of a vehicle as shown in drawing 10 (j=fr, rl) calculates according to the above-mentioned formulas 67 and 68.

[0127] Resultant force of the second target generating force of the resultant force Fm for generating the target yaw moment Mt of a vehicle according to the above-mentioned formula 70 in step 500, i.e., a forward right ring, and a left rear ring calculates, and the target basic generating force Fbxyti of each wheel calculates according to the following formulas 79-82 in step 510.

[0128]

$$F_{bxytfl} = F_{xyt0fl} \dots (79)$$

$$F_{bxytfr} = (F_{xyt0fr} + F_m) / 2 \dots (80)$$

$$F_{bxytrl} = (F_{xyt0rl} + F_m) / 2 \dots (81)$$

$$F_{bxytrr} = F_{xyt0rr} \dots (82)$$

[0129] In addition, in the above-mentioned step 430, 470, 500, since resultant force Fm cannot be attained even if it carries out vector rotation of minimum value Fxyt0min of the first target generating force by setting to Fxyt0min the minimum value of first target generating force Fxyt0j of the wheel specified in step 420, when it is $|F_m| > |F_{xyt0min}|$, resultant force Fm is set as Fxyt0min.

[0130] A correction factor Kr calculates as a value with which the following formula 83 is filled in step 520.

[0131]

[Equation 2]

$$K_r \left\{ \sum_{i=j} \sqrt{F_{xyti}^2 - \left(\frac{F_m}{K_r} \right)^2} + \sum_{i=k} F_{xyti} \right\} = F_{xyt} \dots (83)$$

[0132] According to the second operation gestalt of illustration, in this way by the control law which distributes the target generating force Fxyt of a vehicle in proportion to the touch-down load of each wheel strictly in step 400 The resultant force Fm of the second target generating force for attaining only the target yaw moment Mt of a vehicle, The correction factor Kr to the target basic generating force Fbxyti of each wheel and the target basic generating force of each wheel calculates, and the target generating force Fxyti of each wheel calculates as a product of a correction factor Kr and the target basic generating force Fbxyti in step 550.

[0133] Therefore, since the target generating force Fxyti of each wheel will be calculated so that it may be proportional to the magnitude of the friction circle of each wheel strictly if it puts in another way so that it may be proportional to the touch-down load of

each wheel strictly, the marginal margin to the force which each wheel may generate can be made into max, and, thereby, the force generating capacity of each wheel can be demonstrated to the maximum extent.

[0134] According to the second operation gestalt of illustration, in steps 410, 420, 450, 460, and 490, it is especially based on the sign of product $G_x \cdot G_y$ of the vehicle order acceleration G_x and the lateral acceleration G_y of a vehicle. If it puts in another way, based on the direction of the target generating force F_{xyt} of a vehicle, two wheels which attain the target yaw moment M_t of a vehicle efficiently by vector rotation of the wheel generating force are specified. The resultant force F_m of the second target generating force for generating only the target yaw moment M_t about the vehicle specified in step 430, 470, 500 calculates. In steps 440, 480, and 510, the target basic generating force F_{bxyti} of each wheel calculates based on the resultant force F_m of first target generating force F_{xyti} of each wheel, and the second target generating force. When the magnitude of the target basic generating force F_{bxyti} is amended by the correction factor K_r in step 550, the target generating force F_{xyti} of each wheel calculates.

[0135] When the resultant force F_m of the second target generating force calculates about one wheel or all wheels irrespective of the direction of the target generating force F_{xyt} of a vehicle According to the second operation gestalt of illustration, to the direction of the target generating force F_{xyti} of all wheels becoming in the different direction from the direction of the target generating force F_{xyt} of a vehicle Since the target generating force F_{xyti} of two wheels other than the specified wheel surely becomes the same as that of the direction of the target generating force F_{xyt} of a vehicle The force of acting on the car body of a vehicle vainly as internal stress as compared with the case where the resultant force F_m of the second target generating force calculates, about one wheel or all wheels can be reduced.

[0136] In addition, according to the second operation gestalt of illustration, since steps 50-250 and steps 600-800 are performed like the case of the first above-mentioned operation gestalt, the same operation effectiveness as the above-mentioned operation effectiveness of the first operation gestalt acquired by these steps can be acquired.

[0137] Although this invention was explained to the detail about the specific operation gestalt above, probably this invention will not be limited to an above-mentioned operation gestalt, and it will be clear for this contractor its for other various operation gestalten to be possible within the limits of this invention.

[0138] For example, in the operation gestalt of illustration, a vehicle 12 has the drive system which transmits the engine 10 as a driving source, and the driving torque of a driving source to each wheel by the fixed allocation ratio. The driving force control means which controls the driving force of all wheels in the gross when a braking/driving force control means controls the driving torque of an engine 10 (engine control system 26), Although it consists of a controllable damping force control means (a damping device 42 and electronic control 50) according to the individual, the damping force of each wheel By constituting a vehicle, for example as the so-called vehicle of a wheel in motor type, a driving force control means is controllable according to an individual in the driving force of each wheel, and it may be constituted so that a damping force control means may be controllable according to an individual in the damping force of each wheel.

[0139] Moreover, in the first operation gestalt of illustration, although each wheel is steered by carrying out adjustable control of the effective length of the tie rods 58L, 58R, 68L, and 68R of the hydraulic power-steering equipments 56 and 66 by Actuators 60L, 60R, 70L, and 70R, each wheel may be constituted so that it may be steered with the power steering system respectively prepared according to the individual.

[0140] Moreover, in the first operation gestalt of illustration, although all are $\Delta F_{xyt}(s)$, the sum total of the sum total of second target generating force ΔF_{xytfl} of the right-and-left front wheel for attaining only the target yaw moment M_t of a vehicle, and ΔF_{xytfr} and second target generating force ΔF_{xytrl} of a right-and-left rear wheel, and ΔF_{xytrr} Second target generating force ΔF_{xytfl} of the right-and-left front wheel for attaining only the target yaw moment M_t of a vehicle, Set the sum total of ΔF_{xytfr} to ΔF_{xytf} and the sum total of second target generating force ΔF_{xytrl} of a right-and-left rear wheel and ΔF_{xytrr} is set to ΔF_{xytr} . As long as ΔF_{xytf} and ΔF_{xytr} have fixed relation mutually, ΔF_{xytf} and ΔF_{xytr} may be calculated as a value which is mutually different.

[0141] for example, the ratio of the distance L_r of the vehicle cross direction between the centers of gravity of a vehicle and rear wheel axles -- it may be set up so that it may become L_r/L_f [as opposed to / in the ratio of ΔF_{xytf} / as opposed to ΔF_{xytr} in sum total ΔF_{xytf} of the second target generating force of a front wheel, and sum total ΔF_{xytr} of the second target generating force of a rear wheel / L_f for the distance of the vehicle cross direction between the center of gravity of a vehicle, and a front-wheel axle]

[0142] In this case, the above-mentioned formula 36 and a formula 37 become as the following formula 84 and a formula 85, respectively.

$$M_t = I_y \cdot \gamma \cdot t_d = \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} + \{ (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr} = \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot L / L_r \cdot \Delta F_{xytf} \quad \dots (84)$$

$$K_m = \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot (L / L_r) \quad \dots (85)$$

[0143] Therefore, second target generating force ΔF_{xyti} ($i = fl, fr, rl, rr$) of each wheel for attaining only the target yaw moment M_t of a vehicle is calculated according to the following formulas 86-89.

$$\Delta F_{xytfl} = \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} = \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma \cdot t_d / K_m \quad \dots (86)$$

$$\Delta F_{xytfr} = \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} = \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma \cdot t_d / K_m \quad \dots (87)$$

$$\Delta F_{xytrl} = \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr} = \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \gamma \cdot t_d \cdot (L / L_r) / K_m \quad \dots (88)$$

$$\Delta F_{xytrr} = \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr} = \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \gamma \cdot t_d \cdot (L / L_r) / K_m \quad \dots (89)$$

[0145]

[Effect of the Invention] According to the configuration of claim 1 of this invention, so that more clearly than the above explanation It is based on the amount of steering control operation by the operator, the amount of driving force control operation, and the amount of damping force control operation. The target order force of a vehicle, Since the rudder angle and braking/driving torque of each wheel are controlled so that the target lateral force of a vehicle and the target yaw moment of a vehicle calculate and the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are attained by the generating force of each wheel As compared with the case where only the braking/driving force of each wheel is controlled, the magnitude of the generating force of each wheel and the control range of a direction are expanded. The engine performance of a wheel (tire) can be used effectively, transit movement of a vehicle can be certainly controlled according to an operator's operation by this, and the performance traverse of a vehicle can be raised.

[0146] Moreover, by carrying out feedforward control of the rudder angle and braking/driving force of each wheel so that the generating force of each wheel may turn into the target generating force of corresponding, respectively according to the configuration of claim 1 Since the vehicle order force, lateral force, and the yaw moment are controlled by the target order force of a vehicle, target

lateral force, and the target yaw moment, respectively In the case of the conventional common transit control unit with which the braking/driving force of each wheel is controlled by feedback control according to an individual so that this deflection becomes small based on the deflection of the target behavior index value of a vehicle, and the actual behavior index value of a vehicle, it compares. Transit movement of a vehicle is effectively [certainly and] controllable according to the operation by the operator.

[0147] Moreover, while the direction of resultant force of the target generating force of each wheel meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle according to the configuration of claim 2 Since the magnitude and the direction of the target generating force of each wheel are determined that the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are attained by resultant force of the target generating force of each wheel The magnitude and the direction of the target generating force of each wheel can be determined that the target order force of a vehicle, the target lateral force of a vehicle, and the target yaw moment of a vehicle are efficiently attained by the generating force of each wheel. Therefore, it can prevent certainly that a part of force which each wheel generates acts on the car body of a vehicle vainly as internal stress, and can be made to run a vehicle stably, using most efficiently the force which each wheel generates by this.

[0148] Moreover, the first target generating force of each wheel for attaining the target order force of a vehicle, and the target lateral force of a vehicle according to the configuration of claim 3, without giving the target yaw moment to a vehicle, Since the target generating force of each wheel calculates as the sum with the second target generating force of each wheel for attaining only the target yaw moment, the target generating force of each wheel can be calculated so that the target order force of a vehicle, target lateral force, and the target yaw moment may be attained certainly.

[0149] Moreover, the second target generating force of each wheel attain the target yaw moment can be calculated certainly, without [without the direction of resultant force of the target generating force of each wheel breaks down the relation which meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle according to the configuration of claim 4, and] breaking down greatly the relation in which the target generating force of each wheel is proportional to the touch-down load of each wheel.

[0150] Moreover, the target generating force of each wheel for attaining the target order force of a vehicle, target lateral force, and the target yaw moment can calculate certainly, without according to the configuration of claim 5, the direction of resultant force of the target generating force of each wheel breaking down the relation which meets towards resultant force of the target order force of a vehicle, and the target lateral force of a vehicle, while the target generating force of each wheel is proportional to the touch-down load of each wheel completely.

[0151] Moreover, according to the configuration of claim 6, as a wheel made suitable for generating the second target generating force efficiently, since a wheel with the larger arm length of the yaw moment of the circumference of the center of gravity of the vehicle by the target generating force of [second] the wheels on either side is specified As compared with the case where other wheels are specified, the magnitude of the second target generating force may be small, therefore the amount of amendments to the magnitude of the target generating force of the specified wheel and the target generating force of wheels other than the specified wheel can be made small.

[0152] Moreover, by certainly being able to adjust the direction of the target generating force of the wheel which is not specified towards resultant force of the target order force of a vehicle, and target lateral force, therefore specifying one wheel or all wheels While being able to calculate the target generating force of each wheel easily as compared with the case where the direction of the target generating force of all wheels differs from the direction of resultant force of the target order force of a vehicle, and target lateral force A part of force generated by the wheel can reduce certainly extent which acts on a vehicle vainly as internal stress.

[0153] Moreover, according to the configuration of claim 7, the target rudder angle of each wheel for attaining the target generating force of each wheel and the target braking/driving torque of each wheel can be calculated certainly, and it can calculate certainly according to the configuration of claim 8, without making the target rudder angle of each wheel emit.

[Translation done.]

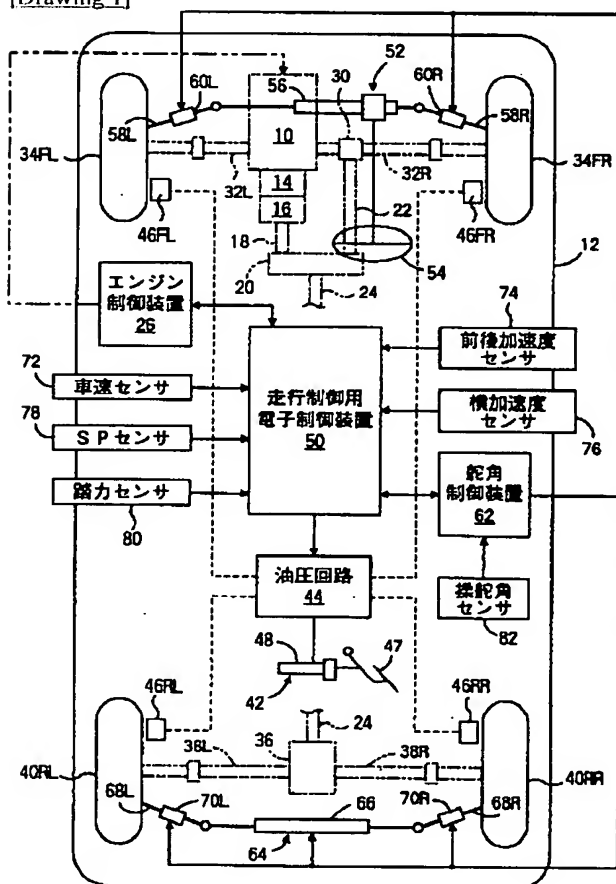
* NOTICES *

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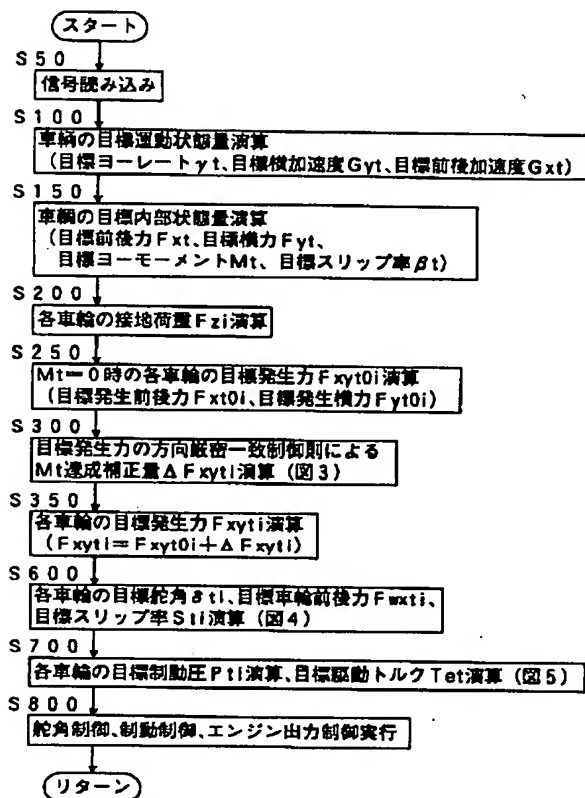
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

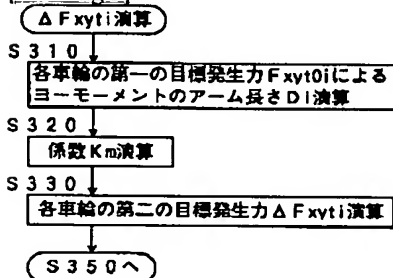
[Drawing 1]



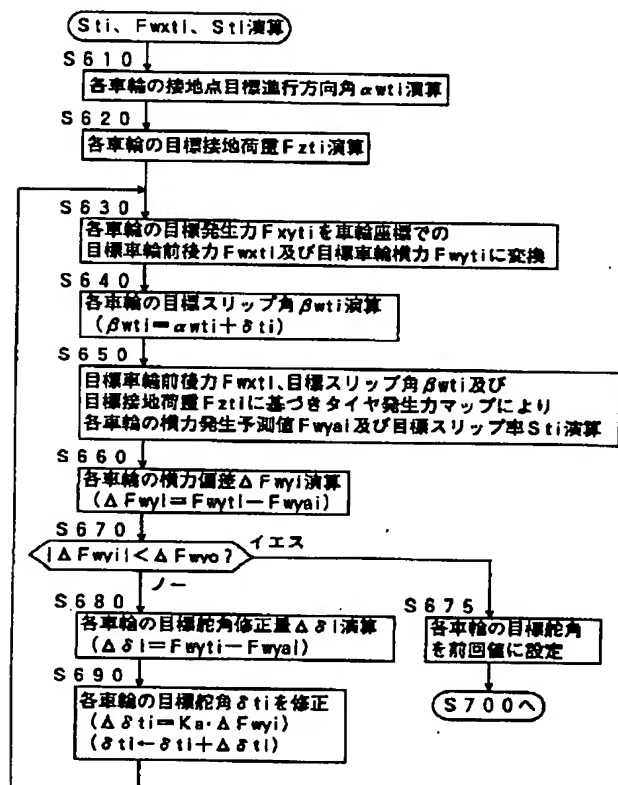
[Drawing 2]



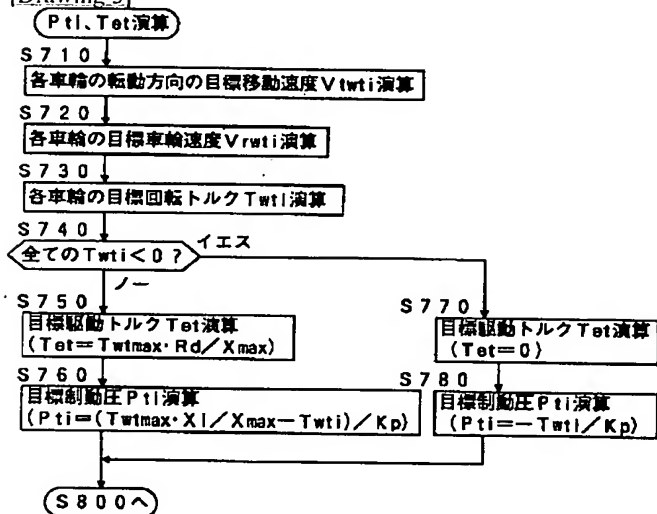
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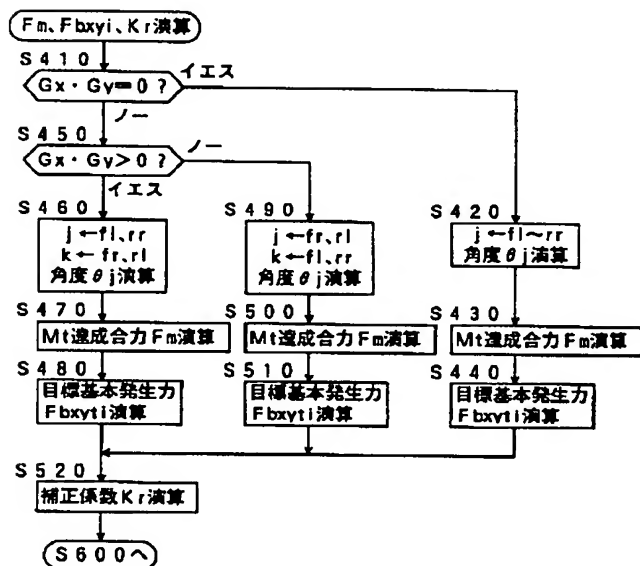
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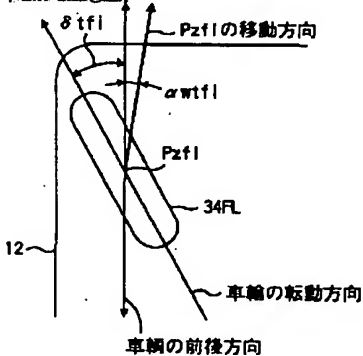
[Drawing 5]



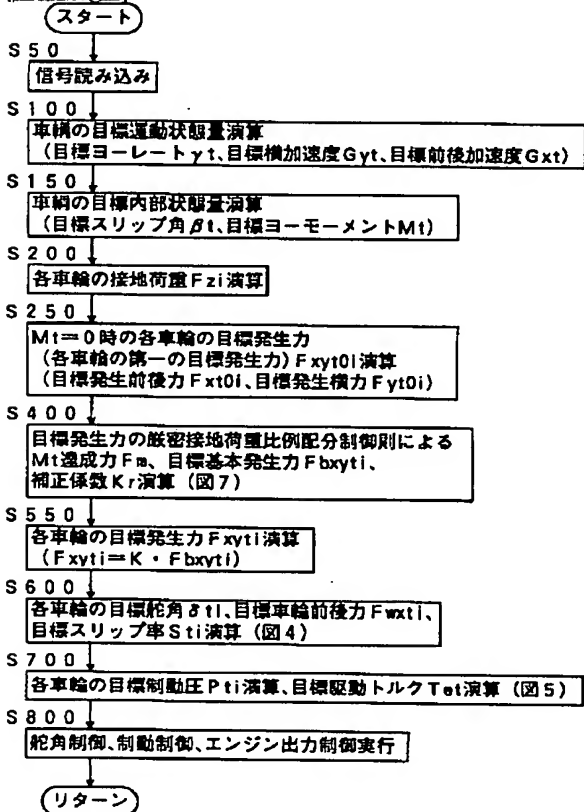
[Drawing 7]



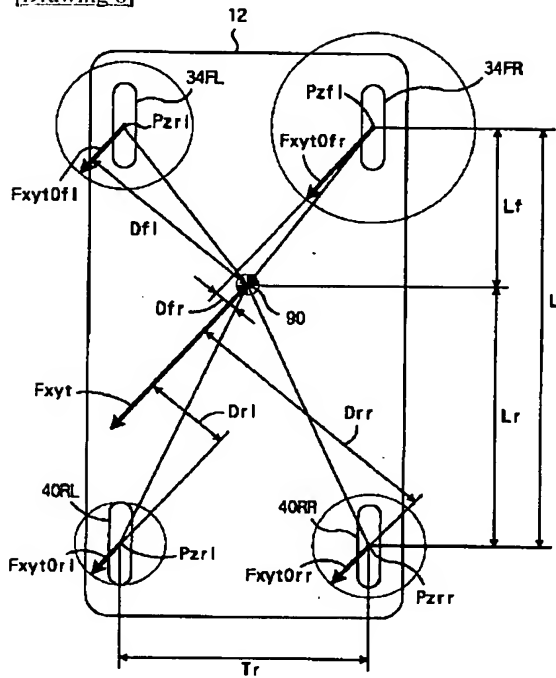
[Drawing 9]



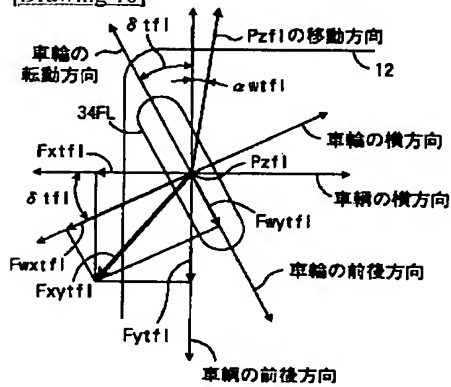
[Drawing 6]



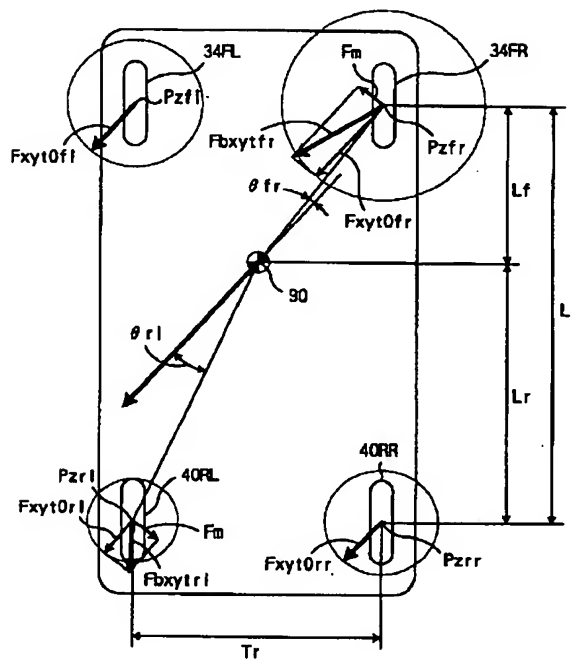
[Drawing 8]



[Drawing 10]



[Drawing 11]



[Translation done.]

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(71)出願人 000003207

トヨタ自動車株式会社

愛知県豊田市トヨタ町1番地

(71)出願人 000003609

株式会社豊田中央研究所

愛知県愛知郡長久手町大字長湫字横道41番地の1

(72)発明者 稲垣 匠二

愛知県豊田市トヨタ町1番地 トヨタ自動車株式会社内

(74)代理人 100071216

弁理士 明石 昌毅

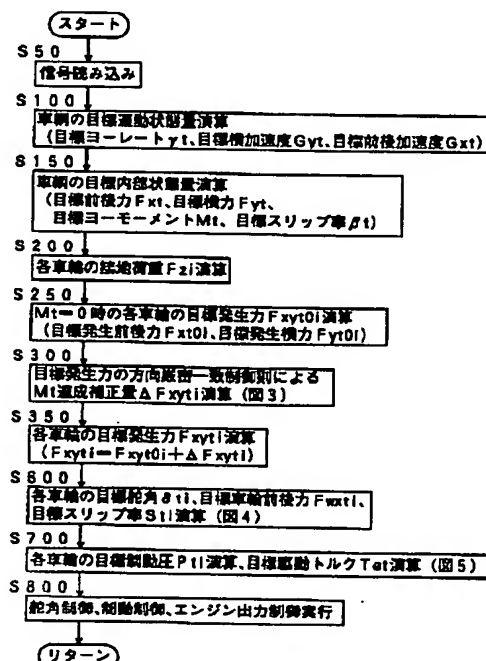
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(54)【発明の名称】 車輛の走行制御装置

(57)【要約】

【課題】 各車輪の舵角をも制御対象として各車輪の発生力を制御することにより、従来の走行制御装置の場合よりも車輛の走行性を向上させる。

【解決手段】 車輛の目標前後力 F_{xt} 、目標横力 F_{yt} 、目標ヨーモーメント M_t が演算され(S100、150)、車輛にヨーモーメントを与えることなく目標前後力 F_{xt} 及び目標横力 F_{yt} を達成する各車輪の第一の目標発生力 F_{xyt0i} が演算され(S200、250)、車輛の目標ヨーモーメント M_t のみを達成するための各車輪の第二の目標発生力 ΔF_{xyti} が演算され(S300)、 F_{xyt0i} と ΔF_{xyti} との和として各車輪の目標発生力 F_{xyti} が演算される(S350)。そして目標発生力 F_{xyti} を達成する各車輪の目標舵角 δ_{ti} 、目標車輪前後力 F_{wxti} 、目標スリップ率 S_{ti} が演算され(S600)、各車輪の目標制動圧 P_{ti} 及びエンジンの目標駆動トルク T_{et} が演算され(S700)、各車輪の舵角が目標舵角 δ_{ti} になり、エンジン10の出力トルクが目標駆動トルク T_{et} になり、各車輪の制動圧が目標制動圧 P_{ti} になるよう制御される(S800)。



【特許請求の範囲】

【請求項1】それぞれ各車輪の舵角及び制駆動力を個別に制御可能な舵角制御手段及び制駆動力制御手段を備えた車輛の走行制御装置にして、運転者による操舵制御操作量を検出する手段と、運転者による駆動力制御操作量を検出する手段と、運転者による制動力制御操作量を検出する手段と、運転者による操舵制御操作量、駆動力制御操作量、制動力制御操作量に基づき車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントを演算する車輛目標状態量演算手段と、前記目標前後力、前記目標横力、前記目標ヨーモーメントに基づき各車輪の目標発生力を演算する車輪目標発生力演算手段と、前記各車輪の目標発生力に基づき各車輪の目標舵角及び目標制駆動トルクを演算する車輪目標制御量演算手段と、各車輪の舵角及び制駆動トルクがそれぞれ前記目標舵角及び前記目標制駆動トルクになるよう前記舵角制御手段及び前記制駆動力制御手段を制御する制御手段とを有することを特徴とする車輛の走行制御装置。

【請求項2】前記車輪目標発生力演算手段は前記各車輪の目標発生力の合力の方向が前記車輛の目標前後力と前記車輛の目標横力との合力の方向に沿うと共に、前記各車輪の目標発生力の合力により前記車輛の目標前後力、前記車輛の目標横力、前記車輛の目標ヨーモーメントが達成されるよう前記各車輪の目標発生力の大きさ及び方向を決定することを特徴とする請求項1に記載の車輛の走行制御装置。

【請求項3】前記車輪目標発生力演算手段は車輛に前記目標ヨーモーメントを与えることなく前記車輛の目標前後力及び前記車輛の目標横力を達成するための各車輪の第一の目標発生力を演算する第一の目標発生力演算手段と、前記目標ヨーモーメントのみを達成するための各車輪の第二の目標発生力を演算する第二の目標発生力演算手段とを有し、前記第一の目標発生力と前記第二の目標発生力との和として前記各車輪の目標発生力を演算することを特徴とする請求項2に記載の車輛の走行制御装置。

【請求項4】前記車輛は左右前輪及び左右後輪を有し、前記車輪目標発生力演算手段は各車輪の接地荷重を求める手段を有し、前記第一の目標発生力演算手段は前記車輛の目標前後力と前記車輛の目標横力との合力を各車輪の接地荷重に比例して各車輪に配分することにより前記各車輪の第一の目標発生力を演算し、前記第二の目標発生力演算手段は前記目標ヨーモーメント及び前記車輛の目標前後力と前記車輛の目標横力との合力の方向に基づき前記目標ヨーモーメントのみを達成するために左右前輪が発生すべき力の合計として前輪のヨーモーメント発生力を演算すると共に左右後輪が発生すべき力の合計として前記前輪のヨーモーメント発生力に対し一定の関係をなす後輪のヨーモーメント発生力を演算する手段と、前記前輪のヨーモーメント発生力を左右前輪の接地荷重

に比例して左右前輪に配分すると共に前記後輪のヨーモーメント発生力を左右後輪の接地荷重に比例して左右後輪に配分することにより前記各車輪の第二の目標発生力を演算する手段とを有することを特徴とする請求項3に記載の車輛の走行制御装置。

【請求項5】前記車輪目標発生力演算手段は各車輪の接地荷重を求める手段を有し、前記第一の目標発生力演算手段は前記車輛の目標前後力と前記車輛の目標横力との合力を各車輪の接地荷重に比例して各車輪に配分することにより前記各車輪の第一の目標発生力を演算し、前記第二の目標発生力演算手段は前記車輛の目標前後力及び前記車輛の目標横力に基づき前記第二の目標発生力を効率的に発生させるに適した車輪を特定する車輪特定手段と、前記特定された車輪について前記第一の目標発生力に垂直な方向の力として前記第二の目標発生力を演算する手段とを有し、前記車輪目標発生力演算手段は前記特定された車輪の目標発生力を前記第一の目標発生力と前記第二の目標発生力との合力に設定する手段と、前記特定された車輪以外の車輪の目標発生力を対応する前記第一の目標発生力に設定する手段と、前記特定された車輪の前記目標発生力と前記特定された車輪以外の車輪の前記目標発生力との合力が前記車輛の目標前後力及び前記車輛の目標横力を達成するよう前記特定された車輪の前記目標発生力及び前記特定された車輪以外の車輪の前記目標発生力の大きさを補正する手段とを有することを特徴とする請求項3に記載の車輛の走行制御装置。

【請求項6】前記車輪特定手段は、前記第二の目標発生力を効率的に発生させるに適した車輪として、左右の車輪のうち前記第二の目標発生力による車輛の重心周りのヨーモーメントのアーム長さが大きい方の車輪を特定することを特徴とする請求項6に記載の車輛の走行制御装置。

【請求項7】前記車輪目標制御量演算手段は車輛の前後方向に対する各車輪の接地点の目標進行方向角を演算する手段と、各車輪の目標接地荷重を演算する手段と、前記目標発生力及び前回の目標舵角に基づき各車輪の車輪座標に於ける目標車輪前後力及び目標車輪横力を演算する手段と、前記各車輪の接地点の目標進行方向角と前回の目標舵角との和として各車輪の目標スリップ角を演算する手段と、前記各車輪の目標車輪前後力、前記各車輪の目標スリップ角、前記各車輪の目標接地荷重に基づき各車輪の横力発生予測値及び目標スリップ率を演算する手段と、前記各車輪の目標車輪前後力、前記各車輪の目標車輪横力、前記各車輪の横力発生予測値、前記各車輪の目標スリップ率に基づき各車輪の目標舵角及び目標回転トルクを演算する手段とを有することを特徴とする請求項1に記載の車輛の走行制御装置。

【請求項8】前記各車輪の目標舵角及び目標回転トルクを演算する手段は、前記目標車輪横力と前記横力発生予測値との偏差の大きさが基準値未満であるときには、各

車輪の目標舵角を前回の目標舵角に設定し、前記目標車輪横力と前記横力発生予測値との偏差の大きさが基準値以上であるときには、前記目標車輪横力と前記横力発生予測値との偏差に基づき目標舵角修正量を演算すると共に、前回の目標舵角が前記目標舵角修正量にて修正された値を各車輪の目標舵角に設定することを特徴とする請求項 7 に記載の車輛の走行制御装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、車輛の走行制御装置に係り、更に詳細には各車輪の舵角及び制駆動力を個別に制御可能な車輛の走行制御装置に係る。

【0002】

【従来の技術】自動車等の車輛の走行制御装置の一つとして、例えば特表平 11-500380 号公表公報に記載されている如く、車輛モデル及びタイヤモデルに基づいて各車輪の制動力を個別に制御することによって車輛のヨーモーメントを制御するよう構成された走行制御装置が従来より知られている。この種の走行制御装置によれば、車輛のヨーモーメントが制御されない場合に比して車輛を安定的に走行させることができる。

【0003】

【発明が解決しようとする課題】一般に、車輛の走行運動は車輛の前後力、横力、ヨーモーメントによって規定され、車輛の前後力、横力、ヨーモーメントは各車輪が路面に対し発生する力の大きさ及び方向により決定される。また車輛を運転者の運転操作に応じて適正に且つ安定的に走行させるためには、車輛の前後力、横力、ヨーモーメントが運転者の操舵制御操作、駆動力制御操作、制動力制御操作に対応する目標値に制御されなければならない。従って車輛の前後力、横力、ヨーモーメントが目標値になるよう、各車輪が路面に対し発生する力の大きさ及び方向が制御されなければならない。

【0004】しかるに上述の如き従来の走行制御装置に於いては、操舵輪の舵角が運転者の操舵制御操作に対応する舵角であり非操舵輪の舵角は一定不変であることを前提として、車輪の制駆動力しか制御されないため、各車輪が発生する力の大きさ及び方向の制御範囲に限界があり、車輪（タイヤ）の性能を最大限に発揮させることができず、従って従来の走行制御装置には車輛の走行性を向上させる点で改善の余地がある。

【0005】また従来の一般的な走行制御装置に於いては、車輛の目標挙動指標値と車輛の実際の挙動指標値との偏差に基づき該偏差が小さくなるようフィードバック制御により各車輪の制駆動力が個別に制御されるようになっており、車輛の実際の挙動が目標挙動よりずれたことに対処すべく走行制御が行われ、またハンチング防止等の制御の安定性確保の必要からフィードバックゲインを高くすることができないため、車輛の走行運動を確実に且つ効果的に制御することができず、従って従来の一

般的な走行制御装置にも車輛の走行性を向上させる点で改善の余地がある。

【0006】本発明は、各車輪の制駆動力を制御することにより車輛の走行運動を制御するよう構成された従来の走行制御装置に於ける上述の如き問題に鑑みてなされたものであり、本発明の主要な課題は、各車輪の舵角をも制御対象とし各車輪が発生する力の大きさ及び方向の制御範囲を拡大すると共に、運転者の運転操作に対応する適正な車輛の走行運動を達成するに必要な大きさ及び方向になるよう各車輪が発生する力の大きさ及び方向を制御することにより、従来の走行制御装置の場合に比して車輛の走行性を向上させることである。

【0007】

【課題を解決するための手段】上述の主要な課題は、本発明によれば、請求項 1 の構成、即ちそれぞれ各車輪の舵角及び制駆動力を個別に制御可能な舵角制御手段及び制駆動力制御手段を備えた車輛の走行制御装置にして、運転者による操舵制御操作量を検出する手段と、運転者による駆動力制御操作量を検出する手段と、運転者による制動力制御操作量を検出する手段と、運転者による操舵制御操作量、駆動力制御操作量、制動力制御操作量に基づき車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントを演算する車輛目標状態量演算手段と、前記目標前後力、前記目標横力、前記目標ヨーモーメントに基づき各車輪の目標発生力を演算する車輪目標発生力演算手段と、前記各車輪の目標発生力に基づき各車輪の目標舵角及び目標制駆動力を演算する車輪目標制御量演算手段と、各車輪の舵角及び制駆動力がそれぞれ前記目標舵角及び前記目標制駆動力になるよう前記舵角制御手段及び前記制駆動力制御手段を制御する制御手段とを有することを特徴とする車輛の走行制御装置によって達成される。

【0008】上記請求項 1 の構成によれば、車輛は各車輪の舵角を個別に制御可能な舵角制御手段を備え、運転者による操舵制御操作量、駆動力制御操作量、制動力制御操作量に基づき車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントが演算され、車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントに基づき各車輪の目標発生力が演算され、各車輪の目標発生力に基づき各車輪の目標舵角及び目標制駆動トルクが演算され、各車輪の舵角及び制駆動トルクがそれぞれ目標舵角及び目標制駆動トルクになるよう制御されるので、各車輪の発生力により車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントが達成されるよう各車輪の舵角及び制駆動トルクが制御され、これにより各車輪の制駆動力のみが制御される場合に比して確実に車輛の走行性が向上する。

【0009】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項 1 の構成に於いて、前記車輪目標発生力演算手段は前記各車輪の目標発生力の

合力の方向が前記車輛の目標前後力と前記車輛の目標横力との合力の方向に沿うと共に、前記各車輪の目標発生力の合力により前記車輛の目標前後力、前記車輛の目標横力、前記車輛の目標ヨーモーメントが達成されるよう前記各車輪の目標発生力の大きさ及び方向を決定するよう構成される（請求項2の構成）。

【0010】請求項2の構成によれば、各車輪の目標発生力の合力の方向が車輛の目標前後力及び車輛の目標横力の合力の方向に沿うと共に、各車輪の目標発生力の合力により車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントが達成されるよう各車輪の目標発生力の大きさ及び方向が決定されるので、各車輪の発生力により車輛の目標前後力、車輛の目標横力、車輛の目標ヨーモーメントが効率的に達成されるよう各車輪の目標発生力の大きさ及び方向が決定される。

【0011】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項2の構成に於いて、前記車輪目標発生力演算手段は車輛に前記目標ヨーモーメントを与えることなく前記車輛の目標前後力及び前記車輛の目標横力を達成するための各車輪の第一の目標発生力を演算する第一の目標発生力演算手段と、前記目標ヨーモーメントのみを達成するための各車輪の第二の目標発生力を演算する第二の目標発生力演算手段とを有し、前記第一の目標発生力と前記第二の目標発生力との和として前記各車輪の目標発生力を演算するよう構成される（請求項3の構成）。

【0012】請求項3の構成によれば、車輛に目標ヨーモーメントを与えることなく車輛の目標前後力及び車輛の目標横力を達成するための各車輪の第一の目標発生力が演算され、目標ヨーモーメントのみを達成するための各車輪の第二の目標発生力が演算され、第一の目標発生力と第二の目標発生力との和として各車輪の目標発生力が演算されるので、車輛の目標前後力、目標横力、目標ヨーモーメントが確実に達成されるよう各車輪の目標発生力が演算される。

【0013】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項3の構成に於いて、前記車輛は左右前輪及び左右後輪を有し、前記車輪目標発生力演算手段は各車輪の接地荷重を求める手段を有し、前記第一の目標発生力演算手段は前記車輛の目標前後力と前記車輛の目標横力との合力を各車輪の接地荷重に比例して各車輪に配分することにより前記各車輪の第一の目標発生力を演算し、前記第二の目標発生力演算手段は前記目標ヨーモーメント及び前記車輛の目標前後力と前記車輛の目標横力との合力の方向に基づき前記目標ヨーモーメントのみを達成するために左右前輪が発生すべき力の合計として前輪のヨーモーメント発生力を演算すると共に左右後輪が発生すべき力の合計として前記前輪のヨーモーメント発生力に対し一定の関係をなす後輪のヨーモーメント発生力を演算する手段と、前記前輪のヨー

モーメント発生力を左右前輪の接地荷重に比例して左右前輪に配分すると共に前記後輪のヨーモーメント発生力を左右後輪の接地荷重に比例して左右後輪に配分することにより前記各車輪の第二の目標発生力を演算する手段とを有するよう構成される（請求項4の構成）。

【0014】請求項4の構成によれば、各車輪の接地荷重が求められ、車輛の目標前後力と車輛の目標横力との合力が各車輪の接地荷重に比例して各車輪に配分されることにより各車輪の第一の目標発生力が演算され、目標ヨーモーメント及び車輛の目標前後力と車輛の目標横力との合力の方向に基づき目標ヨーモーメントのみを達成するために左右前輪が発生すべき力の合計として前輪のヨーモーメント発生力が演算されると共に左右後輪が発生すべき力の合計として前輪のヨーモーメント発生力に対し一定の関係をなす後輪のヨーモーメント発生力が演算され、前輪のヨーモーメント発生力が左右前輪の接地荷重に比例して左右前輪に配分されると共に後輪のヨーモーメント発生力が左右後輪の接地荷重に比例して左右後輪に配分されることにより各車輪の第二の目標発生力が演算されるので、各車輪の目標発生力の合力の方向が車輛の目標前後力及び車輛の目標横力の合力の方向に沿う関係を崩すことなく、また各車輪の目標発生力が各車輪の接地荷重に比例する関係を大きく崩すことなく、目標ヨーモーメントを達成する各車輪の第二の目標発生力が確実に演算される。

【0015】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項3の構成に於いて、前記車輪目標発生力演算手段は各車輪の接地荷重を求める手段を有し、前記第一の目標発生力演算手段は前記車輛の目標前後力と前記車輛の目標横力との合力を各車輪の接地荷重に比例して各車輪に配分することにより前記各車輪の第一の目標発生力を演算し、前記第二の目標発生力演算手段は前記車輛の目標前後力及び前記車輛の目標横力に基づき前記第二の目標発生力を効率的に発生させるに適した車輪を特定する車輪特定手段と、前記特定された車輪について前記第一の目標発生力に垂直な方向の力として前記第二の目標発生力を演算する手段とを有し、前記車輪目標発生力演算手段は前記特定された車輪の目標発生力を前記第一の目標発生力と前記第二の目標発生力との合力に設定する手段と、前記特定された車輪以外の車輪の目標発生力を対応する前記第一の目標発生力に設定する手段と、前記特定された車輪の前記目標発生力と前記特定された車輪以外の車輪の前記目標発生力との合力が前記車輛の目標前後力及び前記車輛の目標横力を達成するよう前記特定された車輪の前記目標発生力及び前記特定された車輪以外の車輪の前記目標発生力の大きさを補正する手段とを有するよう構成される（請求項5の構成）。

【0016】請求項5の構成によれば、各車輪の接地荷重が求められ、車輛の目標前後力と車輛の目標横力との

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合力が各車輪の接地荷重に比例して各車輪に配分されることにより各車輪の第一の目標発生力が演算され、車輪の目標前後力及び車輪の目標横力に基づき第二の目標発生力を効率的に発生させるに適した車輪が特定され、該特定された車輪について第一の目標発生力に垂直な方向の力として第二の目標発生力が演算され、特定された車輪の目標発生力が第一の目標発生力と第二の目標発生力との合力に設定され、特定された車輪以外の車輪の目標発生力が対応する第一の目標発生力に設定され、特定された車輪の目標発生力と特定された車輪以外の車輪の目標発生力との合力が車輪の目標前後力及び車輪の目標横力を達成するよう各車輪の目標発生力の大きさが補正されるので、各車輪の目標発生力が完全に各車輪の接地荷重に比例すると共に各車輪の目標発生力の合力の方向が車輪の目標前後力及び車輪の目標横力の合力の方向に沿う関係を崩すことなく、車輪の目標前後力、目標横力、目標ヨーモーメントを達成するための各車輪の目標発生力が確実に演算される。

【0017】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項5の構成に於いて、前記車輪特定手段は、前記第二の目標発生力を効率的に発生させるに適した車輪として、左右の車輪のうち前記第二の目標発生力による車輪の重心周りのヨーモーメントのアーム長さが大きい方の車輪を特定するよう構成される（請求項6の構成）。

【0018】請求項6の構成によれば、第二の目標発生力を効率的に発生させるに適した車輪として、左右の車輪のうち第二の目標発生力による車輪の重心周りのヨーモーメントのアーム長さが大きい方の車輪が特定されるので、他の車輪が特定される場合に比して第二の目標発生力の大きさが小さくてよく、これにより特定された車輪の目標発生力及び特定された車輪以外の車輪の目標発生力の大きさに対する補正量も小さくなる。

【0019】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項1の構成に於いて、前記車輪目標制御量演算手段は車輪の前後方向に対する各車輪の接地点の目標進行方向角を演算する手段と、各車輪の目標接地荷重を演算する手段と、前記目標発生力及び前回の目標舵角に基づき各車輪の車輪座標に於ける目標車輪前後力及び目標車輪横力を演算する手段と、前記各車輪の接地点の目標進行方向角と前回の目標舵角との和として各車輪の目標スリップ角を演算する手段と、前記各車輪の目標車輪前後力、前記各車輪の目標スリップ角、前記各車輪の目標接地荷重に基づき各車輪の横力発生予測値及び目標スリップ率を演算する手段と、前記各車輪の目標車輪前後力、前記各車輪の目標車輪横力、前記各車輪の横力発生予測値、前記各車輪の目標スリップ率に基づき各車輪の目標舵角及び目標回転トルクを演算する手段とを有するよう構成される（請求項7の構成）。

【0020】請求項7の構成によれば、車輪の前後方向に対する各車輪の接地点の目標進行方向角が演算され、各車輪の目標接地荷重が演算され、目標発生力及び前回の目標舵角に基づき各車輪の車輪座標に於ける目標車輪前後力及び目標車輪横力が演算され、各車輪の接地点の目標進行方向角と前回の目標舵角との和として各車輪の目標スリップ角が演算され、各車輪の目標車輪前後力、各車輪の目標スリップ角、各車輪の目標接地荷重に基づき各車輪の横力発生予測値及び目標スリップ率が演算され、各車輪の目標車輪前後力、各車輪の目標車輪横力、各車輪の横力発生予測値、各車輪の目標スリップ率に基づき各車輪の目標舵角及び目標回転トルクが演算されるので、各車輪の目標発生力を達成するための各車輪の目標舵角及び各車輪の目標制駆動トルクが確実に演算される。

【0021】また本発明によれば、上述の主要な課題を効果的に達成すべく、上記請求項7の構成に於いて、前記各車輪の目標舵角及び目標回転トルクを演算する手段は、前記目標車輪横力と前記横力発生予測値との偏差の大きさが基準値未満であるときには、各車輪の目標舵角を前回の目標舵角に設定し、前記目標車輪横力と前記横力発生予測値との偏差の大きさが基準値以上であるときには、前記目標車輪横力と前記横力発生予測値との偏差に基づき目標舵角修正量を演算すると共に、前回の目標舵角が前記目標舵角修正量にて修正された値を各車輪の目標舵角に設定するよう構成される（請求項8の構成）。

【0022】請求項8の構成によれば、目標車輪横力と横力発生予測値との偏差の大きさが基準値未満であるときには、当該車輪の目標舵角が前回の目標舵角に設定され、目標車輪横力と横力発生予測値との偏差の大きさが基準値以上であるときには、目標車輪横力と横力発生予測値との偏差に基づき目標舵角修正量が演算されると共に、前回の目標舵角が目標舵角修正量にて修正された値が当該車輪の目標舵角に設定されるので、各車輪の目標舵角が発散することなく確実に演算される。

【0023】

【課題解決手段の好ましい態様】本発明の一つの好ましい態様によれば、上記請求項1の構成に於いて、車輪目標状態演算手段は運転者による操舵制御操作量、駆動力制御操作量、制動力制御操作量に基づき車輪の目標前後加速度、車輪の目標横加速度、車輪の目標ヨーレートを演算し、車輪の目標前後加速度、車輪の目標横加速度、車輪の目標ヨーレートに基づきそれぞれ車輪の目標前後力、車輪の目標横力、車輪の目標ヨーモーメントを演算するよう構成される（好ましい態様1）。

【0024】本発明の他の一つの好ましい態様によれば、上記請求項1の構成に於いて、制駆動力制御手段は駆動力制御手段と制動力制御手段とよりなるよう構成される（好ましい態様2）。

【0025】本発明の他の一つの好ましい態様によれば、上記好ましい態様2の構成に於いて、駆動力制御手段は全ての車輪の駆動力を総括的に制御し、制動力制御手段は各車輪の制動力を個別に制御可能であるよう構成される（好ましい態様3）。

【0026】本発明の他の一つの好ましい態様によれば、上記好ましい態様2の構成に於いて、駆動力制御手段は各車輪の駆動力を個別に制御可能であり、制動力制御手段は各車輪の制動力を個別に制御可能であるよう構成される（好ましい態様4）。

【0027】本発明の他の一つの好ましい態様によれば、上記請求項1の構成に於いて、車輛は左右前輪及び左右後輪を有する四輪車輛であるよう構成される（好ましい態様5）。

【0028】本発明の他の一つの好ましい態様によれば、上記請求項4の構成に於いて、前輪のヨーモーメント発生力及び後輪のヨーモーメント発生力は同一の値であるよう構成される（好ましい態様6）。

【0029】本発明の他の一つの好ましい態様によれば、上記請求項4の構成に於いて、車輛の重心と前輪車軸との間の車輛前後方向の距離を L_f とし、車輛の重心と後輪車軸との間の車輛前後方向の距離を L_r として、後輪のヨーモーメント発生力の大きさに対する前輪のヨーモーメント発生力の大きさの比は L_r/L_f であるよう構成される（好ましい態様7）。

【0030】本発明の他の一つの好ましい態様によれば、上記請求項4の構成に於いて、各車輪の接地荷重を求める手段は車輛の質量、車輛の前後加速度、車輛の横加速度に基づき推定により各車輪の接地荷重を演算するよう構成される（好ましい態様8）。

【0031】本発明の他の一つの好ましい態様によれば、上記請求項5の構成に於いて、車輛は左右前輪及び左右後輪を有する四輪車輛であり、車輪特定手段は車輛の目標前後力及び車輛の目標横力が0でないときには、車輛の目標前後力の方向及び車輛の目標横力の方向に基づき左前輪及び右後輪又は右前輪及び左後輪の二つの車輪を特定するよう構成される（好ましい態様9）。

【0032】本発明の他の一つの好ましい態様によれば、上記請求項5の構成に於いて、車輛は左右前輪及び左右後輪を有する四輪車輛であり、車輪特定手段は車輛の目標前後力若しくは車輛の目標横力が0であるときには、全ての車輪を特定するよう構成される（好ましい態様10）。

【0033】本発明の他の一つの好ましい態様によれば、上記好ましい態様9又は10の構成に於いて、第二の目標発生力を演算する手段は演算された第二の目標発生力の大きさが特定された車輪の第一の目標発生力の大きさよりも大きいときには、第二の目標発生力の大きさを当該車輪の第一の目標発生力の大きさに補正するよう構成される（好ましい態様11）。

【0034】本発明の他の一つの好ましい態様によれば、上記請求項7の構成に於いて、車輛は駆動源と駆動源の駆動トルクを各車輪へ一定の配分比率にて伝達する駆動系とを有し、制駆動力制御手段は駆動源の駆動トルクを制御することにより全ての車輪の駆動力を総括的に制御する駆動力制御手段と、各車輪の制動力を個別に制御可能である制動力制御手段とよりなり、前記制御手段は各車輪の目標回転トルクのうち駆動側の最大値に基づき駆動源の目標駆動トルクを演算し、目標回転トルクが最大である車輪以外の他の車輪について前記最大値及び他の車輪の目標回転トルクに基づき目標制動力制御量を演算するよう構成される（好ましい態様12）。

【0035】本発明の他の一つの好ましい態様によれば、上記請求項7の構成に於いて、各車輪の目標舵角及び目標回転トルクを演算する手段は各車輪の目標車輪横力及び横力発生予測値に基づき各車輪の目標舵角の修正量を演算し、前回の目標舵角と目標舵角の修正量との和として各車輪の目標舵角を演算するよう構成される（好ましい態様13）。

【0036】本発明の他の一つの好ましい態様によれば、上記請求項7の構成に於いて、各車輪の目標舵角及び目標回転トルクを演算する手段は各車輪の目標スリップ率に基づき各車輪の目標車輪加速度を演算し、各車輪の目標車輪前後力に基づく第一の目標回転トルクと各車輪の目標車輪加速度に基づく第二の目標回転トルクとの和として各車輪の目標回転トルクを演算するよう構成される（好ましい態様14）。

【0037】本発明の他の一つの好ましい態様によれば、上記請求項8の構成に於いて、各車輪の目標舵角及び目標回転トルクを演算する手段は目標車輪横力と横力発生予測値との偏差に比例する値として目標舵角修正量を演算するよう構成される（好ましい態様15）。

【0038】

【発明の実施の形態】以下に添付の図を参照しつつ、本発明を幾つかの好ましい実施形態について詳細に説明する。

【0039】第一の実施形態

図1は本発明による車輛の走行制御装置の第一の実施形態を示す概略構成図である。

【0040】図1に於いて、10は車輛12に搭載された駆動源としてのエンジンを示しており、エンジン10の駆動力はトルクコンバータ14及びトランスミッション16を介して出力軸18へ伝達され、出力軸18の駆動力はセンターディファレンシャル20により前輪用プロペラシャフト22及び後輪用プロペラシャフト24へ伝達される。エンジン10の出力は運転者により操作される図1には示されていないアクセルペダルの踏み込み量等に応じてエンジン制御装置26により制御される。

【0041】前輪用プロペラシャフト22の駆動力は前輪ディファレンシャル30により左前輪車軸32L及び

右前輪車軸32Rへ伝達され、これにより左右の前輪34FL及び34FRが回転駆動される。同様に後輪用プロペラシャフト24の駆動力は後輪ディファレンシャル36により左後輪車軸38L及び右後輪車軸38Rへ伝達され、これにより左右の後輪40RL及び40RRが回転駆動される。

【0042】かくしてトルクコンバータ14、トランスミッション16、センターディファレンシャル20、前輪ディファレンシャル30、後輪ディファレンシャル36等は車輛の駆動系を構成している。特に図示の実施形態の駆動系は左右前輪34FL、34FR及び左右後輪40RL、40RRに対し一定の配分比率にてエンジン10の駆動トルクを配分し、エンジン制御装置26はエンジン10より各車輪へ伝達される駆動トルクを総括的に制御する。

【0043】左右の前輪34FL、34FR及び左右の後輪40RL、40RRの制動力は制動装置42の油圧回路44により対応するホイールシリンダ46FL、46FR、46RL、46RRの制動圧が制御されることによって制御される。図には示されていないが、油圧回路44はリザーバ、オイルポンプ、種々の弁装置等を含み、各ホイールシリンダの制動圧は通常時には運転者によるブレーキペダル47に対する踏力に応じて駆動されるマスタシリンダ48により制御され、また必要に応じて後に詳細に説明する如く走行制御用電子制御装置50により個別に制御される。

【0044】また図1に示されている如く、左右の前輪34FL及び34FRは前輪用操舵装置52により操舵される。図示の実施形態に於いては、前輪用操舵装置52は運転者によるステアリングホイール54の操舵操作にตอบสนองして駆動される油圧式のパワーステアリング装置56を有し、左右の前輪34FL及び34FRはパワーステアリング装置56によりタイロッド58L及び58Rを介して操舵される。

【0045】タイロッド58L及び58Rにはそれぞれそれらの有効長さを可変制御するアクチュエータ60L及び60Rが設けられており、アクチュエータ60L及び60Rは舵角制御装置62により制御され、これにより左右の前輪34FL及び34FRの舵角は相互に独立して、また後輪40RL及び40RRとは独立して制御されるようになっている。

【0046】同様に、左右の後輪40RL及び40RRは後輪用操舵装置64により操舵される。後輪用操舵装置64は運転者によるステアリングホイール54の操舵操作や車速にตอบสนองして駆動される油圧式のパワーステアリング装置66を有し、左右の後輪の40RL及び40RRはパワーステアリング装置66によりタイロッド68L及び68Rを介して操舵される。

【0047】タイロッド68L及び68Rにはそれぞれそれらの有効長さを可変制御するアクチュエータ70L及

び70Rが設けられており、パワーステアリング装置66及びアクチュエータ70L、70Rは舵角制御装置62により制御され、これにより左右の後輪40RL及び40RRの舵角は相互に独立して、また前輪34FL及び34FRとは独立して制御されるようになっている。

【0048】以上の説明より解る如く、前輪用操舵装置52、後輪用操舵装置64、舵角制御装置62は各車輪34FL、34FR、40RL、40RRの舵角を個別に制御可能な舵角制御手段を構成しており、エンジン10、エンジン制御装置26、制動装置42、電子制御装置50は互いに共働して各車輪の制駆動力を個別に制御可能な制駆動力制御手段を構成しており、電子制御装置50は舵角制御手段及び制駆動力制御手段を制御する制御手段として機能する。

【0049】電子制御装置50には車速センサ72より車速 V_x を示す信号、前後加速度センサ74及び横加速度センサ76よりそれぞれ車輛12の前後加速度 G_x 及び横加速度 G_y を示す信号、シフトポジション(SP)センサ78よりトランスミッション16のシフトポジションPsを示す信号、踏力センサ80よりブレーキペダル47に対する踏力 F_b (運転者による制動制御操作量)を示す信号が入力される。尚運転者による制動制御操作量はマスタシリンダ48内の圧力又はブレーキペダル47の踏み込みストロークにより検出されてもよい。

【0050】また電子制御装置50にはエンジン制御装置26よりエンジン回転数 N_e を示す信号及びスロットル開度 T_a (運転者による駆動力制御操作量)を示す信号が入力され、操舵角センサ82より舵角制御装置62を経て操舵角 θ (運転者による操舵制御操作量)を示す信号が入力される。尚運転者による駆動力制御操作量はアクセルペダルの踏み込みストロークにより検出されてもよい。

【0051】尚前後加速度センサ74は車輛の加速方向を正として前後加速度を検出し、横加速度センサ76及び操舵角センサ82は車輛の左旋回方向を正として横加速度等を検出する。またエンジン制御装置26、電子制御装置50、舵角制御装置62は実際にはそれぞれ例えばCPU、ROM、RAM、入出力装置を含むマイクロコンピュータ及び駆動回路にて構成されてよい。

【0052】後に詳細に説明する如く、挙動制御用電子制御装置50は図2に示されたルーチンに従って、まず車速 V_x 等に基づき車輛の目標運動状態量として車輛の目標ヨーレート $\dot{\gamma}_t$ 、車輛の目標横加速度 G_{yt} 、車輛の目標前後加速度 G_{xt} を演算し、これらに基づき車輛の目標内部状態量として車輛の目標前後加速度 G_{xt} に対応する車輛の目標前後力 F_{xt} 、目標横加速度 G_{yt} に対応する車輛の目標横力 F_{yt} 、目標ヨーレート $\dot{\gamma}_t$ に対応する車輛の目標ヨーモーメント M_t 、車輛の目標スリップ角 β_t を演算する。

【0053】また挙動制御用電子制御装置50は、車輛

の前後加速度 G_x 等に基づき各車輪の垂直荷重 F_{zi} ($i = fl, fr, rl, rr$) を演算し、車輛の目標前後力 F_{xt} 及び車輛の目標横力 F_{yt} の合力として車輛の目標発生力 F_{xyt} を演算し、車輛の目標発生力 F_{xyt} を各車輪の垂直荷重 F_{zi} に応じて各車輪に配分することにより、車輛の目標前後力 F_{xt} 及び車輛の目標横力 F_{yt} を達成する各車輪の第一の目標発生力 F_{xyt0i} ($i = fl, fr, rl, rr$) を車輛の目標発生力 F_{xyt} の方向に沿う方向の力として演算する。

【0054】また挙動制御用電子制御装置50は、各車輪の目標発生力 F_{xyti} を車輛の目標発生力 F_{xyt} の方向に厳密に一致させる制御則により、車輛の目標ヨーモーメント M_t のみを達成するための各車輪の目標発生力の補正量、即ち各車輪の第二の目標発生力 ΔF_{xyti} ($i = fl, fr, rl, rr$) を演算し、第一の目標発生力 F_{xyt0i} と第二の目標発生力 ΔF_{xyti} との和として各車輪の目標発生力 F_{xyti} ($i = fl, fr, rl, rr$) を演算する。

【0055】更に挙動制御用電子制御装置50は、各車輪の発生力を目標発生力 F_{xyti} とするための各車輪の目標舵角 δ_{ti} 、各車輪の車輪座標に於ける目標車輪前後力 F_{wxti} 、各車輪の目標スリップ率 S_{ti} ($i = fl, fr, rl, rr$) を演算し、各車輪の目標車輪前後力 F_{wxti} 及び目標スリップ率 S_{ti} に基づき各車輪の目標回転トルク T_{wti} を演算し、各車輪の目標回転トルク T_{wti} に基づき各車輪の目標制動圧 P_{ti} ($i = fl, fr, rl, rr$) 及びエンジン10の目標駆動トルク T_{et} を演算し、各車輪の舵角 δ_i が目標舵角 δ_{ti} になり、エンジン10の出力トルクが目標駆動トルク T_{et} になるよう舵角制御装置62及び*

$$\gamma_t = \theta \cdot V_x / \{N \cdot L(1 + K_h \cdot V_x^2)\} H(s) \quad \dots\dots (1)$$

$$G_{yt} = \gamma_t \cdot V_x \cdot G(s) \quad \dots\dots (2)$$

$$G_{xt} = F(N_e, T_a, R_d, F_b) \quad \dots\dots (3)$$

【0060】ステップ150に於いては車輛の目標内部状態量として車輛の目標前後加速度 G_{xt} に対応する車輛の目標前後力 F_{xt} 、目標横加速度 G_{yt} に対応する車輛の目標横力 F_{yt} 、目標ヨーレート γ_t に対応する車輛の目標ヨーモーメント M_t 、車輛の目標スリップ角 β_t が演算される。

【0061】特に車輛の目標前後力 F_{xt} 及び目標横力 F_{yt} は車輛の質量を M_v としてそれぞれ下記の式4及び5に従って演算され、目標ヨーモーメント M_t は車輛のヨー慣性モーメントを I_y とし、車輛の目標ヨーレート γ_t の微分値を $\dot{\gamma}_t$ として下記の式6に従って演算され、車輛の目標スリップ角 β_t は下記の式7に従って演算される。

$$F_{xt} = M_v \cdot G_{xt} \quad \dots\dots (4)$$

$$F_{yt} = M_v \cdot G_{yt} \quad \dots\dots (5)$$

$$F_{zfl} = M_v \{ (g \cdot L_r - G_x \cdot H) / (2L) - G_y \cdot H \cdot R_f / T_r \} \quad \dots\dots (8)$$

$$F_{zfr} = M_v \{ (g \cdot L_r - G_x \cdot H) / (2L) + G_y \cdot H \cdot R_f / T_r \} \quad \dots\dots (9)$$

* エンジン制御装置26へ指令信号を出力すると共に、各車輪の制動圧 P_i が目標制動圧 P_{ti} になるよう制動装置42を制御する。

【0056】次に図2乃至図5に示されたフローチャートを参照して第一の実施形態に於ける車輛の走行制御ルーチンについて説明する。尚図2に示されたフローチャートのメインルーチンによる制御は図には示されていないイグニッションスイッチの閉成により開始され、所定の時間毎に繰返し実行される。

【0057】まずステップ50に於いては車速センサ72により検出された車速 V_x を示す信号等の読み込みが行われ、ステップ100に於いては車速 V_x 等に基づき車輛の目標運動状態量として車輛の目標ヨーレート γ_t 、車輛の目標横加速度 G_{yt} 、車輛の目標前後加速度 G_{xt} が演算される。

【0058】例えば目標ヨーレート γ_t はステアリングギヤ比を N とし、車輛のホイールベースを L とし、スタビリティファクタを K_h とし、操舵ヨーレート過渡伝達関数を $H(s)$ として下記の式1に従って演算され、目標横加速度 G_{yt} はヨーレート横加速度過渡伝達関数を $G(s)$ として下記の式2により演算され、目標前後加速度 G_{xt} はエンジン回転数 N_e 、スロットル開度 T_a 、トランスミッション16のシフトポジション P_s に基づく駆動系のギヤ比 R_d 、ブレーキペダルに対する踏力 F_b を変量として車輛の目標前後加速度を演算するための関数 $F(N_e, T_a, R_d, F_b)$ により下記の式3に従って演算される。

【0059】

$$\gamma_t = \dot{\gamma}_t \quad \dots\dots (6)$$

$$\beta_t = \int (G_{yt} / V_x - \gamma_t) dt \quad \dots\dots (7)$$

【0063】ステップ200に於いては図8及び図11に示されている如く車輛12の重心90と前輪車軸との間の車輛前後方向の距離を L_f とし、車輛の重心と後輪車軸との間の車輛前後方向の距離を L_r とし、車輛の重心高さを H とし、前輪及び後輪のロール剛性配分をそれぞれ R_f 及び R_r ($R_f + R_r = 1$) とし、車輛のトレッドを T_r とし、重力加速度を g として、それぞれ下記の式8～11に従って各車輪の接地荷重 F_{zi} ($i = fl, fr, rl, rr$) が演算される。尚下記の式8～11に於ける前後加速度 G_x 及び横加速度 G_y は車速 V_x 等に基づいて推定される値又は目標前後加速度 G_{xt} 及び目標横加速度 G_{yt} であってよい。

【0064】

15

$$F_{zrl} = Mv \{ (g \cdot Lf + Gx \cdot H) / (2L) - Gy \cdot H \cdot Rr / Tr \} \quad \dots\dots (10)$$

16

$$F_{zrr} = Mv \{ (g \cdot Lf + Gx \cdot H) / (2L) + Gy \cdot H \cdot Rr / Tr \} \quad \dots\dots (11)$$

【0065】ステップ250に於いては下記の式12に従って車輪の目標前後力 F_{xt} 及び目標横力 F_{yt} の合力として車輪の目標発生力 F_{xyt} が演算されると共に、下記の式13が成立するので、車輪に目標ヨーモーメント M_t を与えることなく車輪の目標発生力 F_{xyt} を達成する各*

*車輪の目標発生力、即ち各車輪の第一の目標発生力 F_{xyt0i} ($i = fl, fr, rl, rr$) が下記の式14~17に従って演算される。

【0066】

$$F_{xyt} = (F_{xt}^2 + F_{yt}^2)^{1/2} \quad \dots\dots (12)$$

$$F_{zfl} + F_{zfr} + F_{zrl} + F_{zrr} = Mv \cdot g \quad \dots\dots (13)$$

$$F_{xyt0fl} = F_{xyt} \cdot F_{zfl} / (Mv \cdot g) \quad \dots\dots (14)$$

$$F_{xyt0fr} = F_{xyt} \cdot F_{zfr} / (Mv \cdot g) \quad \dots\dots (15)$$

$$F_{xyt0rl} = F_{xyt} \cdot F_{zrl} / (Mv \cdot g) \quad \dots\dots (16)$$

$$F_{xyt0rr} = F_{xyt} \cdot F_{zrr} / (Mv \cdot g) \quad \dots\dots (17)$$

【0067】この場合、車輪の目標発生力 F_{xyt} を達成する各車輪の目標発生力 F_{xyt0i} の車輪前後方向の成分及び車輪横方向の成分をそれぞれ F_{xt0i} 及び F_{yt0i} ($i = fl, fr, rl, rr$) とし、左右前輪及び左右後輪の車輪横方向の成分の合計をそれぞれ F_{yt0f} 及び F_{yt0r} とし、左前後輪及び右前後輪の車輪前後方向の成分の合計をそれぞれ F_{xt0L} 及び F_{xt0R} とすると、これらの合計の力はそれぞれ下記の式18~21により表される。

※後輪の接地荷重を F_{zr} とし、左前後輪の接地荷重を F_{zL} とし、右前後輪の接地荷重を F_{zR} として、合計の力 F_{yt0f} 、 F_{yt0r} 、 F_{xt0L} 、 F_{xt0R} はそれぞれ下記の式22~25により表される。

$$F_{yt0f} = F_{zfl} + F_{zfr} / g \quad \dots\dots (22)$$

$$F_{yt0r} = F_{zrl} + F_{zrr} / g \quad \dots\dots (23)$$

$$F_{xt0L} = F_{zL} \cdot Gx / g \quad \dots\dots (24)$$

$$F_{xt0R} = F_{zR} \cdot Gx / g \quad \dots\dots (25)$$

【0070】尚上記各式に於ける左右前輪の接地荷重 F_{zf} 、左右後輪の接地荷重 F_{zr} 、左前後輪の接地荷重 F_{zL} 、右前後輪の接地荷重 F_{zR} はそれぞれ下記の式26~29により表される。

【0071】

【0068】

$$F_{yt0f} = F_{yt0fl} + F_{yt0fr} \quad \dots\dots (18)$$

$$F_{yt0r} = F_{yt0rl} + F_{yt0rr} \quad \dots\dots (19)$$

$$F_{xt0L} = F_{xt0fl} + F_{xt0rl} \quad \dots\dots (20)$$

$$F_{xt0R} = F_{xt0fr} + F_{xt0rr} \quad \dots\dots (21)$$

【0069】また左右前輪の接地荷重を F_{zf} とし、左右※

$$F_{zf} = F_{zfl} + F_{zfr} \\ = Mv \cdot g \cdot Lr / L - Mv \cdot Gx \cdot H / L \quad \dots\dots (26)$$

$$F_{zr} = F_{zrl} + F_{zrr} \\ = Mv \cdot g \cdot Lf / L + Mv \cdot Gx \cdot H / L \quad \dots\dots (27)$$

$$F_{zL} = F_{zfl} + F_{zrl} \\ = Mv \cdot g / 2 - Mv \cdot Gy \cdot H / Tr \quad \dots\dots (28)$$

$$F_{zR} = F_{zfr} + F_{zrr} \\ = Mv \cdot g / 2 + Mv \cdot Gy \cdot H / Tr \quad \dots\dots (29)$$

【0072】更に車輪の目標ヨーモーメント M_t は下記の式30にて演算され、この式30に上記式22~25及び式26~29を代入すると、式30の右辺は0にな

★る。従って上記式14~17式により求められる各車輪の第一の目標発生力 F_{xyt0i} は車輪にヨーモーメントを与えないことが解る。

$$M_t = I_y \cdot \gamma_{td} \\ = Lf \cdot F_{yt0f} - Lr \cdot F_{yt0r} + (F_{xt0L} - F_{xt0R}) \cdot Tr / 2 \quad \dots\dots (30)$$

【0073】ステップ300に於いては後述の図3に示されたルーチンに従って各車輪の目標発生力 F_{xyti} を車輪の目標発生力 F_{xyt} の方向に厳密に一致させる制御則により、車輪の目標ヨーモーメント M_t のみを達成するための各車輪の目標発生力の補正量、即ち各車輪の第二の目標発生力 ΔF_{xyti} ($i = fl, fr, rl, rr$) が演算される。

【0074】ステップ350に於いては下記の式24に従ってステップ250に於いて演算された各車輪の第一の目標発生力 F_{xyt0i} とステップ300に於いて演算された各車輪の第二の目標発生力 ΔF_{xyti} との和として各車輪の目標発生力 F_{xyti} ($i = fl, fr, rl, rr$) が演算される。

$$F_{xyti} = F_{xyt0i} + \Delta F_{xyti} \quad \dots\dots (31)$$

【0075】ステップ600に於いては後述の図4に示されたルーチンに従って各車輪の目標舵角 δ_{ti} 、各車輪の車輪座標に於ける目標車輪前後力 F_{wxti} 、各車輪の目標スリップ率 S_{ti} ($i = fl, fr, rl, rr$) が演算される。

【0076】ステップ700に於いては後述の図5に示されたルーチンに従って各車輪の目標制動圧 P_{ti} 及びエンジン10の目標駆動トルク T_{et} が演算され、ステップ800に於いては各車輪の舵角 δ_i が目標舵角 δ_{ti} になり、エンジン10の出力トルクが目標駆動トルク T_{et} になるよう舵角制御装置62及びエンジン制御装置26へ指令信号が出力され、また各車輪の制動圧 P_i が目標制

$$D_{fl} = |F_{yt0fl} \cdot T_r / 2 + F_{xt0fl} \cdot L_{fl}| \quad \dots (32)$$

$$D_{fr} = |-F_{yt0fr} \cdot T_r / 2 + F_{xt0fr} \cdot L_{fl}| \quad \dots (33)$$

$$D_{rl} = |F_{yt0rl} \cdot T_r / 2 - F_{xt0rl} \cdot L_{rl}| \quad \dots (34)$$

$$D_{rr} = |-F_{yt0rr} \cdot T_r / 2 - F_{xt0rr} \cdot L_{rl}| \quad \dots (35)$$

【0079】尚図8及び後述の図11に於いて、各車輪の接地点 P_{zi} ($i = fl, fr, rl, rr$) を中心として示された円は各車輪の接地荷重 F_{zi} の大小関係、従って摩擦円の大小関係を示している。

【0080】ステップ320に於いては車輪の目標ヨーモーメント M_t のみを達成するための左右前輪の第二の目標発生力 ΔF_{xytfl} 、 ΔF_{xytfr} の合計及び左右後輪の※

$$\begin{aligned} M_t &= I_y \cdot \gamma_{td} \\ &= \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xyt} \\ &\quad + \{ (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xyt} \\ &= \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \\ &\quad + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xyt} \end{aligned} \quad \dots (36)$$

$$\begin{aligned} K_m &= (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \\ &\quad + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \quad \dots (37) \end{aligned}$$

【0082】ステップ330に於いては下記の式38～41に従って車輪の目標ヨーモーメント M_t のみを達成するための各車輪の第二の目標発生力 ΔF_{xyti} ($i = f$ ★

$$\begin{aligned} \Delta F_{xytfl} &= \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xyt} \\ &= \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (38) \end{aligned}$$

$$\begin{aligned} \Delta F_{xytfr} &= \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xyt} \\ &= \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (39) \end{aligned}$$

$$\begin{aligned} \Delta F_{xytrl} &= - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xyt} \\ &= - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (40) \end{aligned}$$

$$\begin{aligned} \Delta F_{xytrr} &= - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xyt} \\ &= - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (41) \end{aligned}$$

【0084】図4に示された各車輪の目標舵角 δ_{ti} 、各車輪の目標車輪前後力 F_{wxti} 、各車輪の目標スリップ率 S_{ti} 演算ルーチンのステップ610に於いては、下記の式42～45に従って各車輪の接地点の目標進行方向角 α_{wti} ($i = fl, fr, rl, rr$) が演算される。尚左前輪 ☆

$$\alpha_{wtfl} = (\beta_t \cdot V_x + L_{fl} \cdot \gamma_t) / (V_x - T_r \cdot \gamma_t / 2) \quad \dots (42)$$

$$\alpha_{wtfr} = (\beta_t \cdot V_x + L_{fl} \cdot \gamma_t) / (V_x + T_r \cdot \gamma_t / 2) \quad \dots (43)$$

$$\alpha_{wtrl} = (\beta_t \cdot V_x - L_{rl} \cdot \gamma_t) / (V_x - T_r \cdot \gamma_t / 2) \quad \dots (44)$$

※ 動圧 P_{ti} になるよう制動装置42が制御されることにより、各車輪の発生力がそれぞれ対応する目標発生力 F_{xyti} に制御され、しかる後ステップ50へ戻る。

【0077】図3に示された各車輪の第二の目標発生力 ΔF_{xyti} 演算ルーチンのステップ310に於いては、図8に示されている如く、上述のステップ250に於いて演算された各車輪の第一の目標発生力 F_{xyt0i} により車輪12に対しその重心90の周りに与えられる各ヨーモーメントのアーム長さ D_i ($i = fl, fr, rl, rr$) が下記の式32～35に従って演算される。

【0078】

※ 第二の目標発生力 ΔF_{xytrl} 、 ΔF_{xytrr} の合計を ΔF_{xyt} とし、合計の力 ΔF_{xyt} が左右の車輪の接地荷重に応じて配分されるとすると、下記の式36が成立するので、式36の右辺第三式に於ける合計の力 ΔF_{xyt} の係数 K_m が下記の式37に従って演算される。

【0081】

★ l, fr, rl, rr が演算される。

【0083】

☆ について図9に示されている如く、接地点の目標進行方向角 α_{wti} は各車輪の接地点 P_{zi} の目標進行方向が車輪の前後方向に対しなす角度である。

【0085】

$$\alpha_{wtrr} = (\beta_t \cdot V_x - L_r \cdot \gamma_t) / (V_x + T_r \cdot \gamma_t / 2) \quad \dots (45)$$

【0086】ステップ620に於いては上述の式8~11にそれぞれ対応する下記の式46~49に従って車輪の目標前後加速度Gxt及び目標横加速度Gytに基づき各車輪の目標接地荷重Fzti (i = fl, fr, rl, rr) が演算される。

$$F_{ztf1} = Mv \{ (g \cdot L_r - G_{xt} \cdot H) / (2L) - G_{yt} \cdot H \cdot R_f / T_r \} \quad \dots (46)$$

$$F_{ztf2} = Mv \{ (g \cdot L_r - G_{xt} \cdot H) / (2L) + G_{yt} \cdot H \cdot R_f / T_r \} \quad \dots (47)$$

$$F_{ztr1} = Mv \{ (g \cdot L_f + G_{xt} \cdot H) / (2L) - G_{yt} \cdot H \cdot R_r / T_r \} \quad \dots (48)$$

$$F_{ztr2} = Mv \{ (g \cdot L_f + G_{xt} \cdot H) / (2L) + G_{yt} \cdot H \cdot R_r / T_r \} \quad \dots (49)$$

【0088】ステップ630に於いては左前輪について図10に示されている如く、各車輪の目標発生力Fxytiが各車輪の車輪座標に於ける目標前後力及び目標横力に分解された値、即ち目標車輪前後力Fwxti及び目標車輪横力Fwyti (i = fl, fr, rl, rr) がそれぞれ下記の式50及び51に従って演算される。

【0089】

$$F_{wxti} = F_{xyti} \cdot \cos(\pi/2 - \delta_{ti}) \\ = F_{xyti} \cdot \sin \delta_{ti} \quad \dots (50)$$

$$F_{wyti} = F_{xyti} \cdot \sin(\pi/2 - \delta_{ti}) \\ = F_{xyti} \cdot \cos \delta_{ti} \quad \dots (51)$$

【0090】ステップ640に於いては下記の式52に従って各車輪の目標スリップ角 β_{wti} (i = fl, fr, rl, rr) が各車輪の接地点目標進行方向角 α_{wti} と目標舵角 δ_{ti} との和として演算される。

$$\beta_{wti} = \alpha_{wti} + \delta_{ti} \quad \dots (52)$$

【0091】ステップ650に於いては各車輪の目標車輪前後力Fwxti、各車輪の目標スリップ角 β_{wti} 及び各車輪の目標接地荷重Fztiに基づき図には示されていないタイヤ発生力マップ又はタイヤモデルに基づく演算式により各車輪の横力発生予測値Fwyai及び目標スリップ率Sti (i = fl, fr, rl, rr) が演算される。

【0092】ステップ660に於いては下記の式53に従って各車輪について目標車輪横力Fwytiと横力発生予測値Fwyaiとの偏差 ΔF_{wyi} (i = fl, fr, rl, rr) が演算される。

※

$$V_{wxtf1} = V_x + T_r \cdot \gamma / 2 \quad \dots (55)$$

$$V_{wxtf2} = V_x - T_r \cdot \gamma / 2 \quad \dots (56)$$

$$V_{wxtr1} = V_{wxtf1} \quad \dots (57)$$

$$V_{wxtr2} = V_{wxtf2} \quad \dots (58)$$

$$V_{twti} = V_{wxti} (\cos \delta_{ti} - \tan \beta_{wti} \cdot \sin \delta_{ti}) \quad \dots (59)$$

【0097】ステップ720に於いては目標スリップ率Sti及び転動方向の目標移動速度Vrwtiに基づき下記の式60に従って各車輪の目標車輪速度Vrwti (i = fl, fr, rl, rr) が演算される。

$$V_{rwti} = (1 - St_i) V_{twti} \quad \dots (60)$$

【0098】ステップ730に於いては例えば目標車輪速度Vrwtiの時間微分値として各車輪の目標車輪加速度

$$\Delta F_{wyi} = F_{wyti} - F_{wyai} \quad \dots (53)$$

【0093】ステップ670~690は例えば左前輪、右前輪、左後輪、右後輪の順に各車輪について実行され、特にステップ670に於いては車輪横力の偏差 ΔF_{wyi} の絶対値が基準値 ΔF_{wyo} (正の定数) 未満であるか否かの判別、即ち目標舵角 δ_{ti} の修正が不要であるか否かの判別が行われ、否定判別が行われたときにはステップ680へ進み、肯定判別が行われたときにはステップ675に於いて目標舵角 δ_{ti} が前回値に設定された後ステップ700へ進む。

【0094】ステップ680に於いてはKsを正の定数として下記の式54に従って各車輪の目標舵角の修正量 $\Delta \delta_{ti}$ (i = fl, fr, rl, rr) が演算され、ステップ690に於いては各車輪の目標舵角 δ_{ti} (i = fl, fr, rl, rr) が $\delta_{ti} + \Delta \delta_{ti}$ に修正され、しかる後ステップ630へ戻る。

$$\Delta \delta_{ti} = K_s \cdot \Delta F_{wyi} \quad \dots (54)$$

【0095】図5に示された各車輪の目標制動圧Pti及びエンジンの目標駆動トルクTeti演算ルーチンのステップ710に於いては、下記の式55~58に従って各車輪の接地点の目標前後速度Vwxti (i = fl, fr, rl, rr) が演算されると共に、下記の式59に従って各車輪の転動方向の目標移動速度Vtwti (i = fl, fr, rl, rr) が演算される。

【0096】

Vrwti (i = fl, fr, rl, rr) が演算されると共に、車輪の有効半径をRwとし、車輪の回転慣性モーメントをIwとして下記の式61に従って各車輪の目標回転トルクTwti (i = fl, fr, rl, rr) が演算される。

$$T_{wti} = F_{wxti} \cdot R_w + I_w \cdot V_{rwti} \quad \dots (61)$$

【0099】ステップ740に於いては全ての車輪の目標回転トルクTwtiが負の値であるか否かの判別、即ち

全ての車輪について制動が必要な状況であるか否かの判別が行われ、肯定判別が行われたときにはステップ770へ進み、否定判別が行われたときにはステップ750へ進む。

【0100】ステップ750に於いてはシフトポジションPsに基づき駆動系のギヤ比Rdが求められると共に、駆動系による各車輪に対するエンジン10の駆動トルクの配分率をXi (i = fl, fr, rl, rr) (0 < Xi < 0.5, $\sum Xi = 1$) とし、四輪の目標回転トルクTwtiのうちの最大値をTwtmaxとし、目標回転トルクが最大値Twtmax*10

$$P_{ti} = (T_{wtmax} \cdot X_i / X_{max} - T_{wti}) / K_p \quad \dots\dots (63)$$

【0102】ステップ770に於いてはエンジン10の目標駆動トルクTetが0に設定され、ステップ780に於いては各車輪の目標制動圧Ptiが下記の式64に従って演算され、しかる後ステップ800へ進む。

$$P_{ti} = -T_{wti} / K_p \quad \dots\dots (64)$$

【0103】かくして図示の第一の実施形態によれば、ステップ100に於いて車速Vx等に基づき車輪の目標運動状態量として車輪の目標ヨーレート γ_t 、車輪の目標横加速度Gyt、車輪の目標前後加速度Gxtが演算され、ステップ150に於いて車輪の目標内部状態量として車輪の目標前後加速度Gxtに対応する車輪の目標前後力Fxt、目標横加速度Gytに対応する車輪の目標横力Fyt、目標ヨーレート γ_t に対応する車輪の目標ヨーモーメントMt、車輪の目標スリップ角 β_t が演算される。

【0104】またステップ200に於いて各車輪の垂直荷重Fziが演算され、ステップ250に於いて車輪の目標前後力Fxt及び目標横力Fytの合力として車輪の目標発生力Fxytiが演算されると共に、車輪にヨーモーメントを与えることなく車輪の目標発生力Fxytiを達成する各車輪の第一の目標発生力Fxyti0iが演算され、ステップ300に於いて各車輪の目標発生力Fxytiを車輪の目標発生力Fxyti0iの方向に厳密に一致させる制御則により、車輪の目標ヨーモーメントMtのみを達成するための各車輪の第二の目標発生力 ΔF_{xyti} が演算され、ステップ350に於いて第一の目標発生力Fxyti0iと第二の目標発生力 ΔF_{xyti} との和として各車輪の目標発生力Fxytiが演算される。

【0105】従って図示の第一の実施形態によれば、車輪の目標前後力Fxt、目標横力Fyt、目標ヨーモーメントMtを確実に達成するよう、換言すれば車輪の目標ヨーレート γ_t 、車輪の目標横加速度Gyt、車輪の目標前後加速度Gxtを確実に達成するよう、各車輪の目標発生力Fxytiを演算することができ、これにより運転者による操舵制御操作量（操舵角 θ ）、駆動力制御操作量（スロットル開度Ta）、制動制御操作量（ブレーキペダル踏力Fb）に応じた所望の運動状態にて車輪を安定的に走行させることができる。

【0106】また全ての車輪の目標発生力Fxytiの方向を車輪の目標発生力Fxytの方向に完全に整合させるこ

* tmaxである車輪（最大駆動トルク車輪）の駆動トルク配分率をXmaxとして、エンジン10の目標駆動トルクTetが下記の式62に従って演算される。

$$T_{et} = T_{wtmax} \cdot R_d / X_{max} \quad \dots\dots (62)$$

【0101】ステップ760に於いては最大駆動トルク車輪の目標制動圧Ptiが0に設定されると共に、制動圧と制動トルクとの変換係数をKpとして最大駆動トルク車輪以外の各車輪の目標制動圧Ptiが下記の式63に従って演算され、しかる後ステップ800へ進む。

とができるので、各車輪が発生する力の一部が車輪12の車体に内部応力として無駄に作用することを確実に防止することができ、これにより各車輪が発生する力を最も効率的に利用して車輪を安定的に走行させることができる。

【0107】また図示の第一の実施形態によれば、ステップ600に於いて各車輪の目標発生力Fxytiを達成する各車輪の目標舵角 δ_{ti} 、各車輪の車輪座標に於ける目標車輪前後力Fwxti、各車輪の目標スリップ率Stiが演算され、ステップ700に於いて各車輪の目標制動圧Pti及びエンジン10の目標駆動トルクTetが演算され、ステップ800に於いて各車輪の舵角 δ_i が目標舵角 δ_{ti} になり、エンジン10の出力トルクが目標駆動トルクTetになるよう舵角制御装置62及びエンジン制御装置26へ指令信号が出力され、また各車輪の制動圧Piが目標制動圧Ptiになるよう制動装置42が制御されることにより、各車輪の発生力がそれぞれ対応する目標発生力Fxytiに制御される。

【0108】従って図示の第一の実施形態によれば、各車輪の発生力がそれぞれ対応する目標発生力Fxytiになるよう各車輪の舵角及び制駆動力が制御されるので、車輪の制駆動力しか制御されない従来の走行制御装置の場合に比して、各車輪の発生力の大きさ及び方向の制御範囲を拡大し、車輪（タイヤ）の性能を有効に利用することができ、これにより各車輪の発生力を対応する目標発生力Fxytiに確実に制御することができる。

【0109】また図示の第一の実施形態によれば、上述の如く各車輪の発生力がそれぞれ対応する目標発生力Fxytiになるよう各車輪の舵角及び制駆動力がフィードバック制御されることにより、車輪の前後加速度Gx、横加速度Gy、ヨーレート γ がそれぞれ車輪の目標前後加速度Gxt、目標横加速度Gyt、目標ヨーレート γ_t に制御されるので、車輪の目標挙動指標値と車輪の実際の挙動指標値との偏差に基づき該偏差が小さくなるようフィードバック制御により各車輪の制駆動力が個別に制御される従来の一般的な走行制御装置の場合に比して、応答遅れやハンチング等の問題を生じることなく車輪の走行運動を確実に且つ効果的に運転者による運転操作に応じて制御することができる。

【0110】特に図示の第一の実施形態によれば、ステップ600に於いて各車輪の発生力を目標発生力 F_{xyti} とするための各車輪の目標舵角 δ_{ti} 、各車輪の車輪座標に於ける目標車輪前後力 F_{wxti} 、各車輪の目標スリップ率 S_{ti} が演算され、ステップ710及び720に於いて目標スリップ率 S_{ti} に基づき各車輪の目標車輪速度 $V_{rw_{ti}}$ が演算され、ステップ730に於いて各車輪の目標車輪加速度 $V_{rwd_{ti}}$ が演算されると共に、各車輪の目標車輪前後力 F_{wxti} 及び目標車輪加速度 $V_{rwd_{ti}}$ に基づき各車輪の目標回転トルク T_{wti} が演算されるので、各車輪の目標スリップ率 S_{ti} に基づいて演算される目標車輪加速度 $V_{rwd_{ti}}$ が考慮されない場合に比して、各車輪の目標回転トルク T_{wti} を正確に演算することができる。

【0111】また図示の第一の実施形態によれば、各車輪の目標回転トルク T_{wti} のうち駆動側の最大値 T_{wtmax} に基づき駆動源としてのエンジン10の目標駆動トルク T_{et} が演算され、目標回転トルクが最大である車輪以外の他の車輪について最大値 T_{wtmax} 及び他の車輪の目標回転トルク T_{wti} に基づき目標制動圧 P_{ti} が演算されるので、エンジン10をその駆動トルクが目標駆動トルク T_{et} になるよう制御すると共に、上記他の車輪の制動圧 P_i を目標制動圧 P_{ti} に制御することにより、容易に且つ確実に各車輪の発生力を目標発生力 F_{xyti} に制御することができる。

【0112】また図示の第一の実施形態によれば、ステップ660に於いて目標車輪横力 F_{wyti} と横力発生予測値 F_{wyati} との偏差 ΔF_{wyti} が演算され、ステップ670～690に於いて目標車輪横力 F_{wyti} と横力発生予測値 F_{wyati} との偏差 ΔF_{wyti} の大きさが基準値未満であるときには、当該車輪の目標舵角 δ_{ti} が前回の目標舵角に設定され、目標車輪横力 F_{wyti} と横力発生予測値 F_{wyati} との偏差 ΔF_{wyti} の大きさが基準値以上であるときには、偏差 ΔF_{wyti} に基づき目標舵角修正量 $\Delta \delta_{ti}$ が演算されると共に、前回の目標舵角が目標舵角修正量 $\Delta \delta_{ti}$ にて修正された値が当該車輪の目標舵角 δ_{ti} に設定されるので、各車輪の目標舵角 δ_{ti} を分散させることなく確実に演算することができる。

【0113】第二の実施形態

図6は本発明による四輪車輛の走行制御装置の第二の実

$$\theta_{fl} = \tan^{-1} |F_{xt0fl} / F_{yt0fl}| - \tan^{-1} |2L_f / T_r| \quad \dots (66)$$

$$\theta_{fr} = \tan^{-1} |F_{xt0fr} / F_{yt0fr}| - \tan^{-1} |2L_f / T_r| \quad \dots (67)$$

$$\theta_{rl} = \tan^{-1} |F_{xt0rl} / F_{yt0rl}| - \tan^{-1} |2L_r / T_r| \quad \dots (68)$$

$$\theta_{rr} = \tan^{-1} |F_{xt0rr} / F_{yt0rr}| - \tan^{-1} |2L_r / T_r| \quad \dots (69)$$

【0119】ステップ430に於いては下記の式70に従って車輛の目標ヨーモーメント M_t のみを発生させるための合力、即ちステップ420に於いて特定された四

$$F_m = I_y \cdot \gamma_t / \sum_{i=j} \cos \theta_i \quad \dots (70)$$

【0121】ステップ440に於いては下記の式71～74に従って各車輪の目標基本発生力 F_{bxyti} ($i = f$

* 施形態に於ける各車輪の舵角制御及び制駆動力制御のメインルーチンを示すフローチャートである。尚図6に於いて、図2に示されたステップに対応するステップには図2に於いて付されたステップ番号と同一のステップ番号が付されている。

【0114】この実施形態のステップ50～250及びステップ600～800は上述の第一の実施形態と同様に実行され、ステップ250の次に実行されるステップ400に於いては図7に示されたルーチンに従って車輛の目標発生力 F_{xyt} を厳密に各車輪の接地荷重に比例して配分する制御則により、車輛の目標ヨーモーメント M_t のみを達成するための各車輪の発生力（第二の目標発生力）の合力 F_m 、各車輪の目標基本発生力 F_{bxyti} ($i = fl, fr, rl, rr$)、各車輪の目標基本発生力に対する補正係数 K_r が演算される。

【0115】ステップ550に於いては各車輪の目標発生力 F_{xyti} が下記の式65に従って補正係数 K_r と目標基本発生力 F_{bxyti} との積として演算され、しかる後ステップ600へ進む。

$$F_{xyti} = K_r \cdot F_{bxyti} \quad \dots (65)$$

【0116】図7に示された各車輪の第二の目標発生力の合力 F_m 、車輛の目標基本発生力 F_{bxyti} 、補正係数 K_r 演算ルーチンのステップ410に於いては、車輛の前後加速度 G_x と車輛の横加速度 G_y との積が0であるか否かの判別、即ち車輛の前後加速度 G_x 若しくは車輛の横加速度 G_y が0であるか否かの判別が行われ、否定判別が行われたときにはステップ450へ進み、肯定判別が行われたときにはステップ420へ進む。

【0117】ステップ420に於いては車輪発生力のベクトル回転により車輛の目標ヨーモーメント M_t を達成する車輪が左右前輪及び左右後輪に特定されるよう、車輪発生力がベクトル回転される車輪を示す j が fl, fr, rl, rr に設定されると共に、 j が fr 及び rl である場合について図11に示されている如く各車輪の接地点 P_{zi} と車輛の重心 G_0 とを結ぶ線分に対し各車輪の目標発生力 F_{xyti} のベクトルがなす角度 θ_j ($j = fl, fr, rl, rr$) が下記の式66～69に従って演算される。

【0118】

* 輪の第二の目標発生力の合力 F_m が演算される。

【0120】

【数1】

fl, fr, rl, rr が演算される。

$$F_{bxytfl} = (F_{xyt0fl}^2 + F_m^2)^{1/2} \quad \dots (71)$$

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$$F_{bxytfr} = (F_{xyt0fr}^2 + F_m^2)^{1/2} \quad \dots\dots (72)$$

$$F_{bxytrl} = (F_{xyt0rl}^2 + F_m^2)^{1/2} \quad \dots\dots (73)$$

$$F_{bxytrr} = (F_{xyt0rr}^2 + F_m^2)^{1/2} \quad \dots\dots (74)$$

【0122】ステップ450に於いては車輛の前後加速度 G_x と車輛の横加速度 G_y との積が正の値であるか否かの判別が行われ、否定判別が行われたときはステップ490へ進み、肯定判別が行われたときにはステップ460へ進む。尚ステップ410及び450の積に使用される車輛の前後加速度及び横加速度は車速 V_x 等に基づき推定される値であってもよく、また目標前後加速度 G_{xt} 及び目標横加速度 G_{yt} であってもよい。

【0123】ステップ460に於いては車輪発生力のベクトル回転により車輛の目標ヨーモーメント M_t を達成する車輪が左前輪及び右後輪に特定されるよう、車輪発生力がベクトル回転される車輪を示す j が fl 及び rr に設定され、車輪発生力がベクトル回転されない車輪を示す k が fr 及び rl に設定されると共に、左前輪及び右後輪の接地点 P_{zfl} 、 P_{zrr} と車輛の重心 G_0 とを結ぶ線分に対し左前輪及び右後輪の目標発生力 F_{xyt0fl} 及び F_{xyt0rr} のベクトルがなす角度 θ_j ($j = fl, rr$) が上記式66及び69に従って演算される。

【0124】ステップ470に於いては上記式70に従って車輛の目標ヨーモーメント M_t を発生させるための合力 F_m 、即ち左前輪及び右後輪の第二の目標発生力の合力が演算され、ステップ480に於いては下記の式75～78に従って各車輪の目標基本発生力 F_{bxyti} が演算される。

【0125】

$$F_{bxytfl} = (F_{xyt0fl}^2 + F_m^2)^{1/2} \quad \dots\dots (75)$$

$$F_{bxytfr} = F_{xyt0fr} \quad \dots\dots (76)$$

$$F_{bxytrl} = F_{xyt0rl} \quad \dots\dots (77)$$

$$F_{bxytrr} = (F_{xyt0rr}^2 + F_m^2)^{1/2} \quad \dots\dots (78) \quad *$$

【0132】かくして図示の第二の実施形態によれば、ステップ400に於いて車輛の目標発生力 F_{xyt} を厳密に各車輪の接地荷重に比例して配分する制御則により、車輛の目標ヨーモーメント M_t のみを達成するための第二の目標発生力の合力 F_m 、各車輪の目標基本発生力 F_{bxyti} 、各車輪の目標基本発生力に対する補正係数 K_r が演算され、ステップ550に於いて各車輪の目標発生力 F_{xyti} が補正係数 K_r と目標基本発生力 F_{bxyti} との積として演算される。

【0133】従って各車輪の目標発生力 F_{xyti} は各車輪の接地荷重に厳密に比例するよう、換言すれば各車輪の摩擦円の大きさに厳密に比例するよう演算されるので、各車輪が発生し得る力に対する限界マージンを最大にすることができ、これにより各車輪の力発生能力を最大限に発揮させることができる。

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*【0126】ステップ490に於いては車輪の発生力のベクトル回転により車輛の目標ヨーモーメント M_t を達成する車輪が右前輪及び左後輪に特定されるよう、 j が fr 及び rl に設定され、 k が fl 及び rr に設定されると共に、図10に示されている如く右前輪及び左後輪の接地点 P_{zfr} 、 P_{zrl} と車輛の重心 G_0 とを結ぶ線分に対し右前輪及び左後輪の目標発生力 F_{xyt0fr} 及び F_{xyt0rl} のベクトルがなす角度 θ_j ($j = fr, rl$) が上記式67及び68に従って演算される。

【0127】ステップ500に於いては上記式70に従って車輛の目標ヨーモーメント M_t を発生させるための合力 F_m 、即ち右前輪及び左後輪の第二の目標発生力の合力が演算され、ステップ510に於いては下記の式79～82に従って各車輪の目標基本発生力 F_{bxyti} が演算される。

【0128】

$$F_{bxytfl} = F_{xyt0fl} \quad \dots\dots (79)$$

$$F_{bxytfr} = (F_{xyt0fr}^2 + F_m^2)^{1/2} \quad \dots\dots (80)$$

$$F_{bxytrl} = (F_{xyt0rl}^2 + F_m^2)^{1/2} \quad \dots\dots (81)$$

$$F_{bxytrr} = F_{xyt0rr} \quad \dots\dots (82)$$

【0129】尚上述のステップ430、470、500に於いて、ステップ420に於いて特定された車輪の第一の目標発生力 F_{xyt0j} の最小値を $F_{xyt0min}$ として $|F_m| > |F_{xyt0min}|$ であるときには、第一の目標発生力の最小値 $F_{xyt0min}$ をベクトル回転させても合力 F_m を達成することができないので、合力 F_m は $F_{xyt0min}$ に設定される。

【0130】ステップ520に於いては下記の式83を満たす値として補正係数 K_r が演算される。

【0131】

【数2】

$$K_r \left\{ \sum_{i=1}^n \sqrt{F_{xyti}^2 - \left(\frac{F_m}{K_r} \right)^2} + \sum_{i=k}^n F_{xyti} \right\} = F_{xyt} \quad \dots\dots (83)$$

【0134】特に図示の第二の実施形態によれば、ステップ410、420、450、460、490に於いて車輛の前後加速度 G_x と車輛の横加速度 G_y との積 $G_x \cdot G_y$ の符号に基づき、換言すれば車輛の目標発生力 F_{xyt} の方向に基づき、車輪発生力のベクトル回転により車輛の目標ヨーモーメント M_t を効率的に達成する二つの車輪が特定され、ステップ430、470、500に於いて特定された車輛について目標ヨーモーメント M_t のみを発生させるための第二の目標発生力の合力 F_m が演算され、ステップ440、480、510に於いて各車輪の第一の目標発生力 F_{xyt0i} 及び第二の目標発生力の合力 F_m に基づき各車輪の目標基本発生力 F_{bxyti} が演算され、ステップ550に於いて目標基本発生力 F_{bxyti} の大きさが補正係数 K_r によって補正されることにより各車輪の目標発生力 F_{xyti} が演算される。

【0135】車輛の目標発生力 F_{xyt} の方向に拘わらず一つの車輪又は全ての車輪について第二の目標発生力の合力 F_m が演算される場合には、全ての車輪の目標発生力 F_{xyti} の方向が車輛の目標発生力 F_{xyt} の方向とは異なる方向になるのに対し、図示の第二の実施形態によれば、特定された車輪以外の二つの車輪の目標発生力 F_{xyti} は必ず車輛の目標発生力 F_{xyt} の方向と同一になるので、一つの車輪又は全ての車輪について第二の目標発生力の合力 F_m が演算される場合に比して、車輛の車体に内部応力として無駄に作用する力を低減することができる。

【0136】尚図示の第二の実施形態によれば、ステップ50～250及びステップ600～800は上述の第一の実施形態の場合と同様に実行されるので、これらのステップにより得られる上述の第一の実施形態の作用効果と同一の作用効果を得ることができる。

【0137】以上に於ては本発明を特定の実施形態について詳細に説明したが、本発明は上述の実施形態に限定されるものではなく、本発明の範囲内に於て他の種々の実施形態が可能であることは当業者にとって明らかである。

【0138】例えば図示の実施形態に於いては、車輛12は駆動源としてのエンジン10と駆動源の駆動トルクを各車輪へ一定の配分比率にて伝達する駆動系とを有し、制駆動力制御手段はエンジン10の駆動トルクを制御することにより全ての車輪の駆動力を総括的に制御する駆動力制御手段（エンジン制御装置26）と、各車輪の制動力を個別に制御可能である制動力制御手段（制動装置42及び電子制御装置50）とよりなっているが、車輛が例えば所謂ホイールインモータ式の車輛として構

$$M_t = I_y \cdot \gamma_{td}$$

$$\begin{aligned} &= \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} \\ &\quad + \{ (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr} \\ &= \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \\ &\quad + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} \\ &\quad \cdot (L/L_r) \Delta F_{xytf} \quad \dots (84) \end{aligned}$$

$$\begin{aligned} K_m &= \{ (F_{zfl} \cdot D_{fl} + F_{zfr} \cdot D_{fr}) / (F_{zfl} + F_{zfr}) \\ &\quad + (F_{zrl} \cdot D_{rl} + F_{zrr} \cdot D_{rr}) / (F_{zrl} + F_{zrr}) \} (L/L_r) \\ &\quad \dots (85) \end{aligned}$$

【0143】従って車輛の目標ヨーモーメント M_t のみ 40※演算される。

を達成するための各車輪の第二の目標発生力 ΔF_{xyti} 【0144】

($i = fl, fr, rl, rr$) は下記の式86～89に従って※

$$\begin{aligned} \Delta F_{xytfl} &= \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} \\ &= \{ F_{zfl} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (86) \end{aligned}$$

$$\begin{aligned} \Delta F_{xytfr} &= \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot \Delta F_{xytf} \\ &= \{ F_{zfr} / (F_{zfl} + F_{zfr}) \} \cdot I_y \cdot \gamma_{td} / K_m \quad \dots (87) \end{aligned}$$

$$\begin{aligned} \Delta F_{xytrl} &= - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr} \\ &= - \{ F_{zrl} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \gamma_{td} (L/L_r) / K_m \\ &\quad \dots (88) \end{aligned}$$

$$\Delta F_{xytrr} = - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot \Delta F_{xytr}$$

* 成されることにより、駆動力制御手段が各車輪の駆動力を個別に制御可能であり、制動力制御手段が各車輪の制動力を個別に制御可能であるよう構成されてもよい。

【0139】また図示の第一の実施形態に於いては、各車輪は油圧式のパワーステアリング装置56、66のタイロッド58L、58R、68L、68Rの有効長さがアクチュエータ60L、60R、70L、70Rによって可変制御されることにより操舵されるようになっているが、各車輪は各々個別に設けられた操舵装置により操舵されるよう構成されてもよい。

【0140】また図示の第一の実施形態に於いては、車輛の目標ヨーモーメント M_t のみを達成するための左右前輪の第二の目標発生力 ΔF_{xytfl} 、 ΔF_{xytfr} の合計及び左右後輪の第二の目標発生力 ΔF_{xytrl} 、 ΔF_{xytrr} の合計は何れも ΔF_{xyt} であるが、車輛の目標ヨーモーメント M_t のみを達成するための左右前輪の第二の目標発生力 ΔF_{xytfl} 、 ΔF_{xytfr} の合計を ΔF_{xytf} とし、左右後輪の第二の目標発生力 ΔF_{xytrl} 、 ΔF_{xytrr} の合計を ΔF_{xytr} として、 ΔF_{xytf} 及び ΔF_{xytr} が相互に一定の関係性を有する限り、 ΔF_{xytf} 及び ΔF_{xytr} は相互に異なる値として演算されてもよい。

【0141】例えば前輪の第二の目標発生力の合計 ΔF_{xytf} 及び後輪の第二の目標発生力の合計 ΔF_{xytr} は、 ΔF_{xytr} に対する ΔF_{xytf} の比が車輛の重心と前輪車軸との間の車輛前後方向の距離を L_f に対する車輛の重心と後輪車軸との間の車輛前後方向の距離 L_r の比 L_r/L_f になるよう設定されてもよい。

【0142】この場合、上記式36及び式37はそれぞれ下記の式84及び式85の通りになる。

$$= - \{ F_{zrr} / (F_{zrl} + F_{zrr}) \} \cdot I_y \cdot \tau_{td} (L/L_r) / K_m$$

..... (89)

【0145】

【発明の効果】以上の説明より明らかである如く、本発明の請求項1の構成によれば、運転者による操舵制御操作量、駆動力制御操作量、制動力制御操作量に基づき車輪の目標前後力、車輪の目標横力、車輪の目標ヨーモーメントが演算され、各車輪の発生力により車輪の目標前後力、車輪の目標横力、車輪の目標ヨーモーメントが達成されるよう各車輪の舵角及び制駆動トルクが制御されるので、各車輪の制駆動力のみが制御される場合に比して各車輪の発生力の大きさ及び方向の制御範囲を拡大し、車輪（タイヤ）の性能を有効に利用することができ、これにより運転者の運転操作に応じて車輪の走行運動を確実に制御することができ、車輪の走行性を向上させることができる。

【0146】また請求項1の構成によれば、各車輪の発生力がそれぞれ対応する目標発生力になるよう各車輪の舵角及び制駆動力がフィードフォワード制御されることにより、車輪の前後力、横力、ヨーモーメントがそれぞれ車輪の目標前後力、目標横力、目標ヨーモーメントに制御されるので、車輪の目標挙動指標値と車輪の実際の挙動指標値との偏差に基づき該偏差が小さくなるようフィードバック制御により各車輪の制駆動力が個別に制御される従来の一般的な走行制御装置の場合に比して、車輪の走行運動を確実に且つ効果的に運転者による運転操作に応じて制御することができる。

【0147】また請求項2の構成によれば、各車輪の目標発生力の合力の方向が車輪の目標前後力及び車輪の目標横力の合力の方向に沿うと共に、各車輪の目標発生力の合力により車輪の目標前後力、車輪の目標横力、車輪の目標ヨーモーメントが達成されるよう各車輪の目標発生力の大きさ及び方向が決定されるので、各車輪の発生力により車輪の目標前後力、車輪の目標横力、車輪の目標ヨーモーメントが効率的に達成されるよう各車輪の目標発生力の大きさ及び方向を決定することができ、従って各車輪が発生する力の一部が車輪の車体に内部応力として無駄に作用することを確実に防止することができ、これにより各車輪が発生する力を最も効率的に利用して車輪を安定的に走行させることができる。

【0148】また請求項3の構成によれば、車輪に目標ヨーモーメントを与えることなく車輪の目標前後力及び車輪の目標横力を達成するための各車輪の第一の目標発生力と、目標ヨーモーメントのみを達成するための各車輪の第二の目標発生力との和として各車輪の目標発生力が演算されるので、車輪の目標前後力、目標横力、目標ヨーモーメントを確実に達成するよう各車輪の目標発生力を演算することができる。

【0149】また請求項4の構成によれば、各車輪の目標発生力の合力の方向が車輪の目標前後力及び車輪の目

標横力の合力の方向に沿う関係を崩すことなく、また各車輪の目標発生力が各車輪の接地荷重に比例する関係を大きく崩すことなく、目標ヨーモーメントを達成する各車輪の第二の目標発生力を確実に演算することができる。

【0150】また請求項5の構成によれば、各車輪の目標発生力が完全に各車輪の接地荷重に比例すると共に各車輪の目標発生力の合力の方向が車輪の目標前後力及び車輪の目標横力の合力の方向に沿う関係を崩すことなく、車輪の目標前後力、目標横力、目標ヨーモーメントを達成するための各車輪の目標発生力を確実に演算することができる。

【0151】また請求項6の構成によれば、第二の目標発生力を効率的に発生させるに適した車輪として、左右の車輪のうち第二の目標発生力による車輪の重心周りのヨーモーメントのアーム長さが大きい方の車輪が特定されるので、他の車輪が特定される場合に比して第二の目標発生力の大きさが小さくてよく、従って特定された車輪の目標発生力及び特定された車輪以外の車輪の目標発生力の大きさに対する補正量を小さくすることができる。

【0152】また特定されない車輪の目標発生力の方向を確実に車輪の目標前後力及び目標横力の合力の方向に整合させることができ、従って一つの車輪又は全ての車輪が特定されることにより、全ての車輪の目標発生力の方向が車輪の目標前後力及び目標横力の合力の方向とは異なる場合に比して、各車輪の目標発生力を容易に演算することができると共に、車輪により発生される力の一部が車輪に内部応力として無駄に作用する程度を確実に低減することができる。

【0153】また請求項7の構成によれば、各車輪の目標発生力を達成するための各車輪の目標舵角及び各車輪の目標制駆動トルクを確実に演算することができ、請求項8の構成によれば、各車輪の目標舵角を発散させることなく確実に演算することができる。

【図面の簡単な説明】

【図1】本発明による車輪の走行制御装置の第一の実施形態を示す概略構成図である。

【図2】第一の実施形態に於ける走行制御のメインルーチンを示すフローチャートである。

【図3】図2に示されたフローチャートのステップ300に於ける各車輪の第二の目標発生力 ΔF_{xyti} 演算ルーチンを示すフローチャートである。

【図4】図2に示されたフローチャートのステップ600に於ける各車輪の目標舵角 δ_{ti} 、目標車輪前後力 F_{wxti} 、目標スリップ率 S_{ti} 演算ルーチンを示すフローチャートである。

【図5】図2に示されたフローチャートのステップ700

0に於ける各車輪の目標制動圧 P_{ti} 及びエンジンの目標駆動トルク T_{et} 演算ルーチンを示すフローチャートである。

【図6】本発明による車輛の走行制御装置の第二の実施形態に於ける走行制御のメインルーチンを示すフローチャートである。

【図7】図6に示されたフローチャートのステップ400に於ける車輛の目標ヨーモーメント M_t 達成力 F_m 、各車輪の目標基本発生力 F_{bxyti} 、補正係数 K_r 演算ルーチンを示すフローチャートである。

【図8】各車輪の第一の目標発生力 F_{xyt0i} により車輛に対しその重心の周りに与えられる各ヨーモーメントのアーム長さ D_i を示す説明図である。

【図9】左前輪について車輪の接地点の目標進行方向角 α_{wtfl} を示す説明図である。

【図10】左前輪について目標発生力 F_{xytfl} が車輪座標に於ける目標車輪前後力 F_{wxtfl} 及び目標車輪横力 F_{vytfl} に分解される要領を示す説明図である。

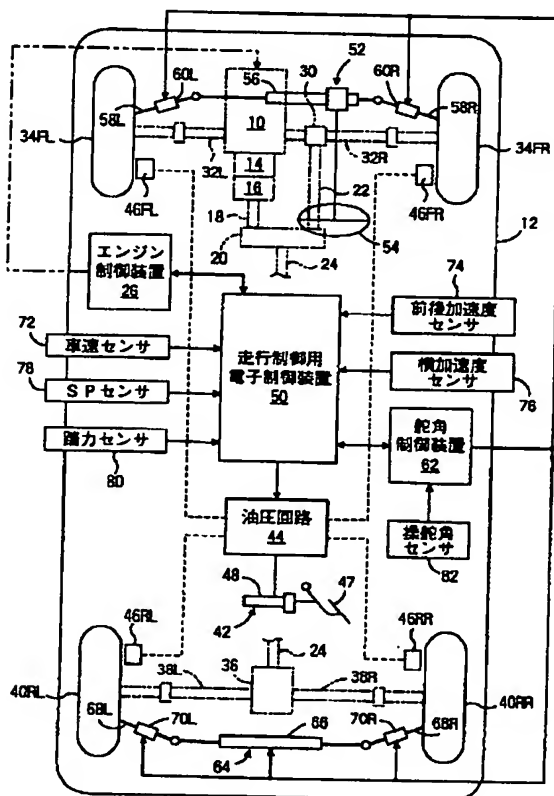
【図11】右前輪及び左後輪の接地点と車輛の重心とを結ぶ線分に対し右前輪及び左後輪の目標発生力 $F_{xytofr} \times 20$

*及び F_{xyt0rl} のベクトルがなす角度 θ_{fr} 及び θ_{rl} を示す説明図である。

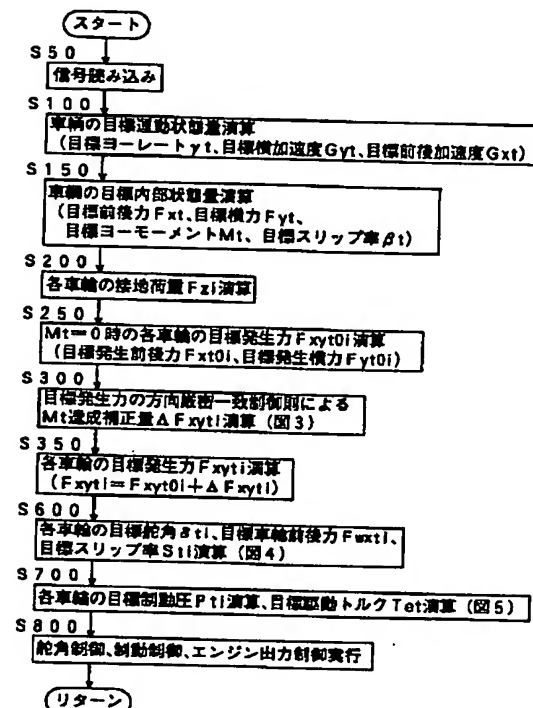
【符号の説明】

- 10…エンジン
- 12…車輛
- 16…トランスミッション
- 18…センターディファレンシャル
- 26…エンジン制御装置
- 42…制動装置
- 44…油圧回路
- 50…走行制御用電子制御装置
- 52…前輪用操舵装置
- 62…舵角制御装置
- 64…後輪用操舵装置
- 72…車速センサ
- 74…前後加速度センサ
- 76…横加速度センサ
- 78…シフトポジションセンサ
- 80…踏力センサ
- 82…操舵角センサ

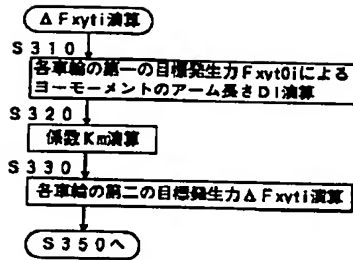
【図1】



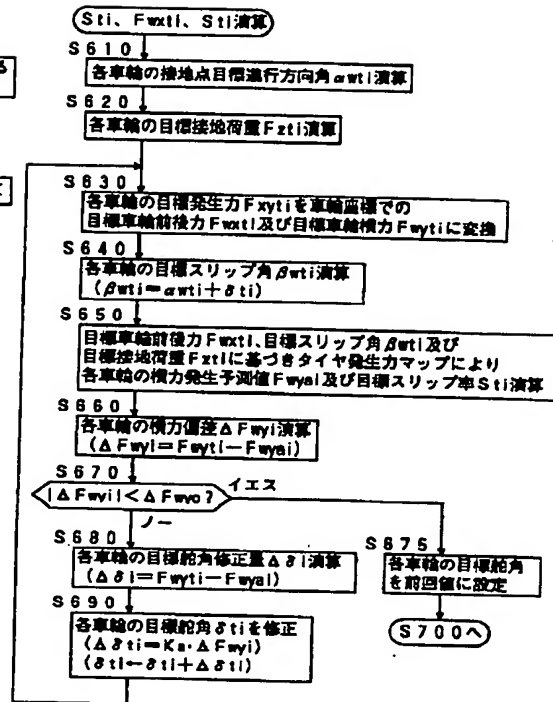
【図2】



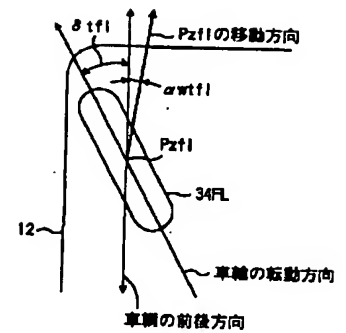
【図3】



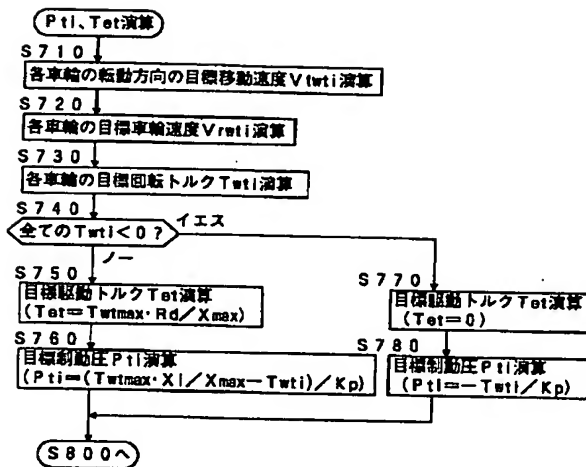
【図4】



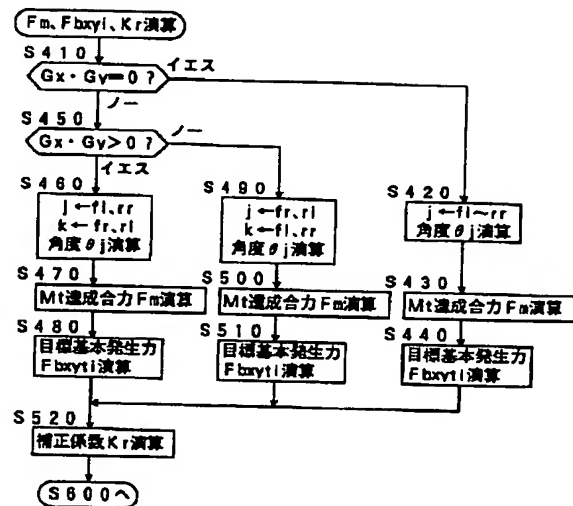
【図9】



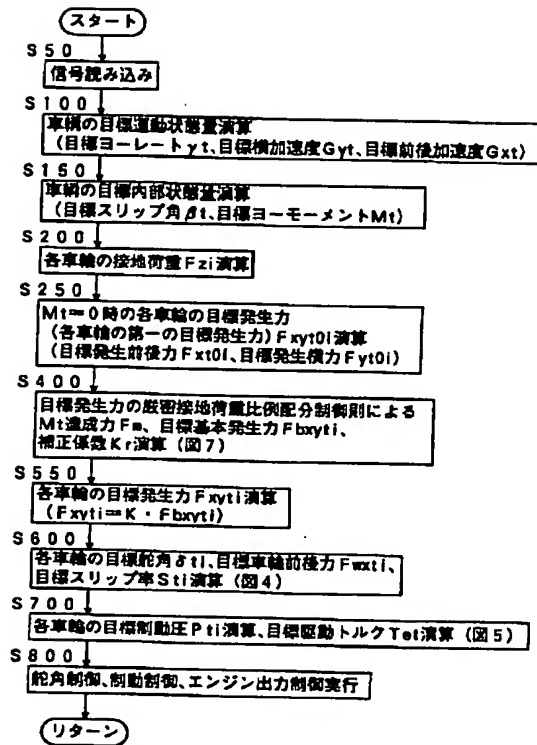
【図5】



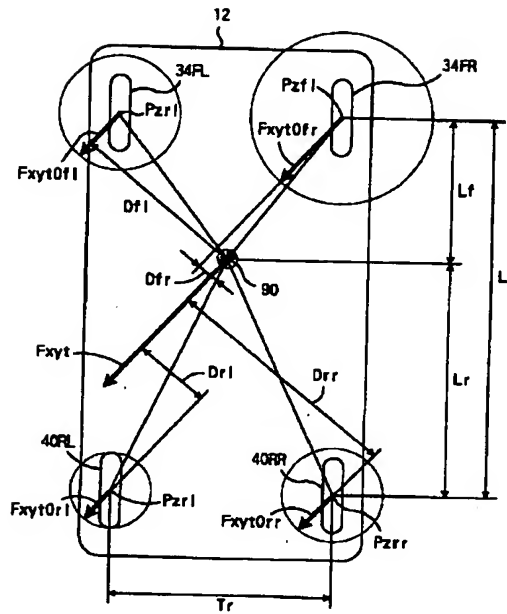
【図7】



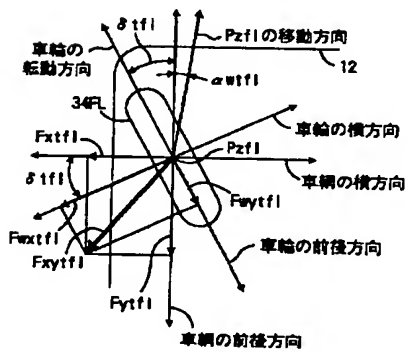
【図6】



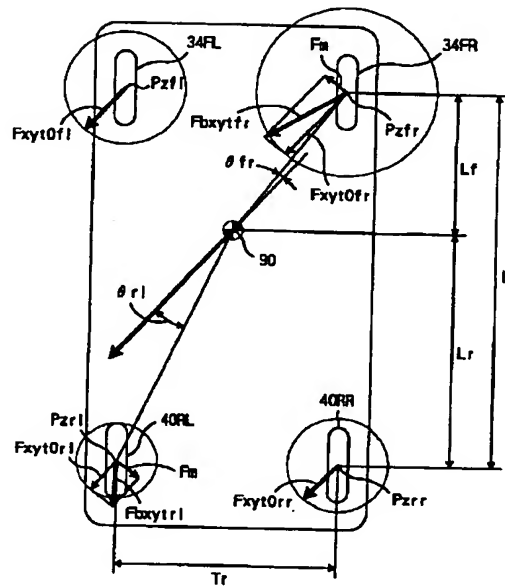
【図8】



【図10】



【図11】



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(72)発明者 服部 義和

愛知県愛知郡長久手町大字長湫字横道41番
 地の1 株式会社豊田中央研究所内

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